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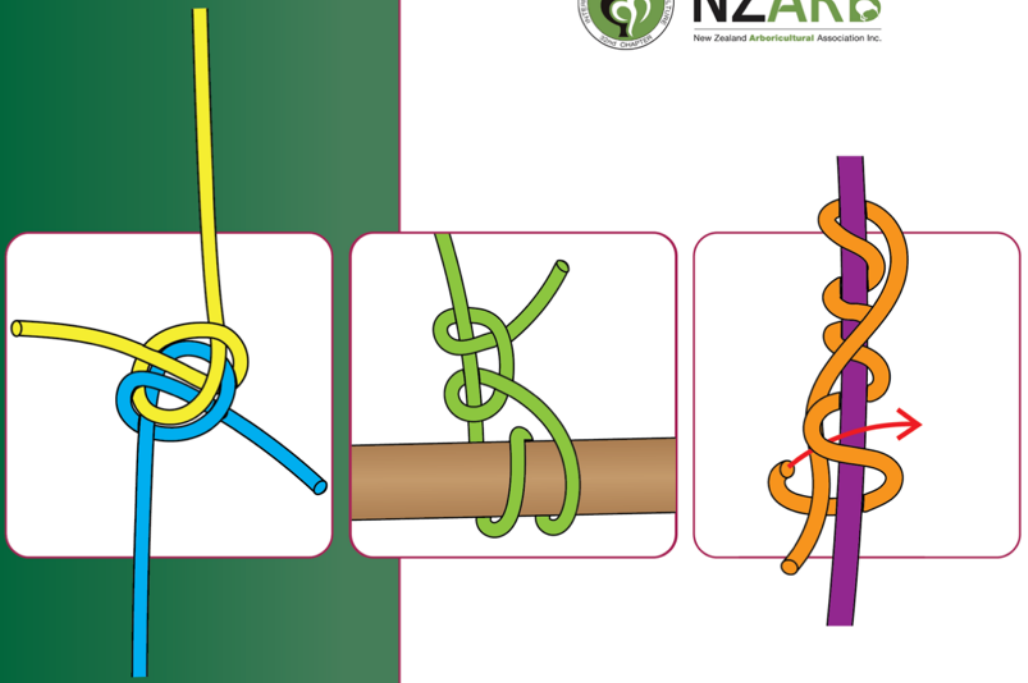

ARBORIST KNOTS

KNOTS, HITCHES AND BENDS FOR TREE CLIMBING AND RIGGING

MIS301

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This document is based in part on material created by Scott Sharpe in 2008 to 2010. This project was something he often discussed. The loss of his knowledge and enthusiasm is strongly felt.

The Minimum Industry Standard series is dedicated to all our fellow workers who have lost their lives or have been permanently injured working in the arboriculture and vegetation management industries.

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A Minimum Industry Standard for arborist knots

This book is one in a series of Minimum Industry Standards produced by Arboriculture Australia Ltd and the New Zealand Arboricultural Association in consultation with the national arboriculture community in both countries. These industry peer-reviewed documents provide a 'body of knowledge' which is shared by practitioners and can be used as the basis for training, dissemination of skills and professional development.

This book covers the basics of knot selection and knot tying, and presents the range of core knots every competent arborist should know. Many other knots exist, some of which may be superior to these core knots for specific work tasks or functions – the knots presented form a solid foundation on which practitioners can build.

Users are advised to consult **MIS302 Arborist Ropes** for more details about rope type, rope properties and rope inspection. Details of the use of knots for climbing and rigging operations are contained within the relevant MISs for those work tasks.

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Knots for arboriculture

Arborists use a huge variety of knots for climbing, aerial rigging, attaching hardware and many other work tasks. Choosing the correct knot for each task is just as important as tying the knot properly.

Before choosing the knot, arborists should consider the job that the knot will be doing, and what properties of the knot will help it to do that job well:

- For rigging, is it important that the knot is strong, doesn't slip during dynamic rigging operations, or is easy to untie?
- For climbing, is it important that the knot cinches onto hardware, doesn't creep, can be tied mid-line, or is compact or strong?

The right knot must be selected for the right purpose. A small selection of knots could be used for almost every requirement in tree work – in fact almost every task in tree work can be performed knowing just a bowline and a prusik – but that does not mean the tasks would be done well.

To do a good job safely, the correct knot must be selected, tied, dressed, set and finished.

Good habits adopted from the start will not need to be unlearned. Sloppy knot tying or poor knot choice have proved fatal for arborists in the past.

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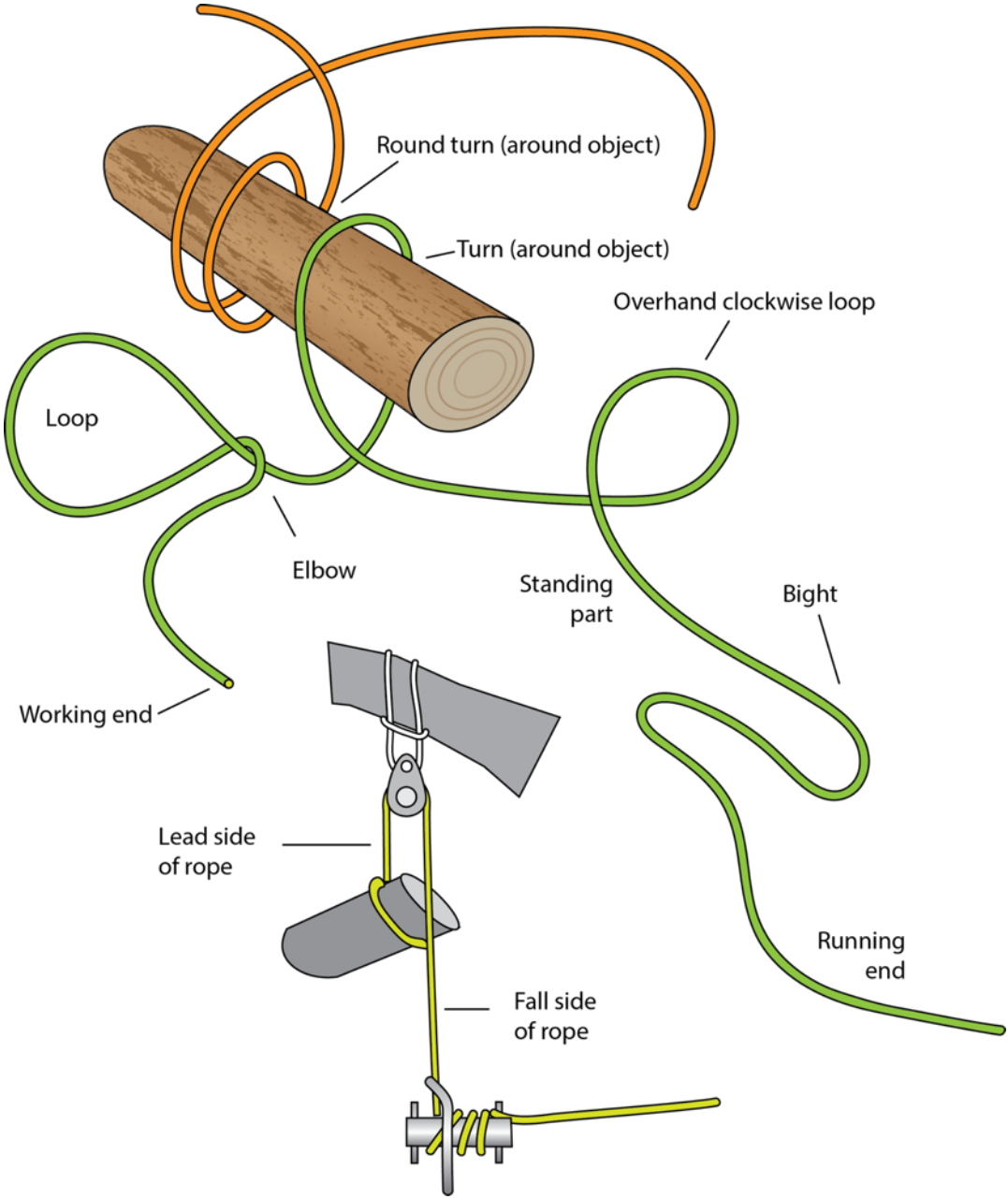
Rope terminology and knot tying principles



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The correct arboricultural terminology should always be used to refer to the respective parts and configurations of rope, and to easily identify and communicate which part of a rope is being used at a particular stage of tying a knot.

The **working end** is the end that is used to tie a knot; the **running end** is the end not used. The running end may still be in use in climbing/rigging situations.

The rope in between the two ends is the **standing part**.

There are other various loops and turns are made in the rope to help form knots called either a **bight**, a **loop**, an **elbow** or an **uncrossed loop**.

A **turn** is where the rope loops around an object; a **round turn** is where the rope loops an additional 360° around the object.

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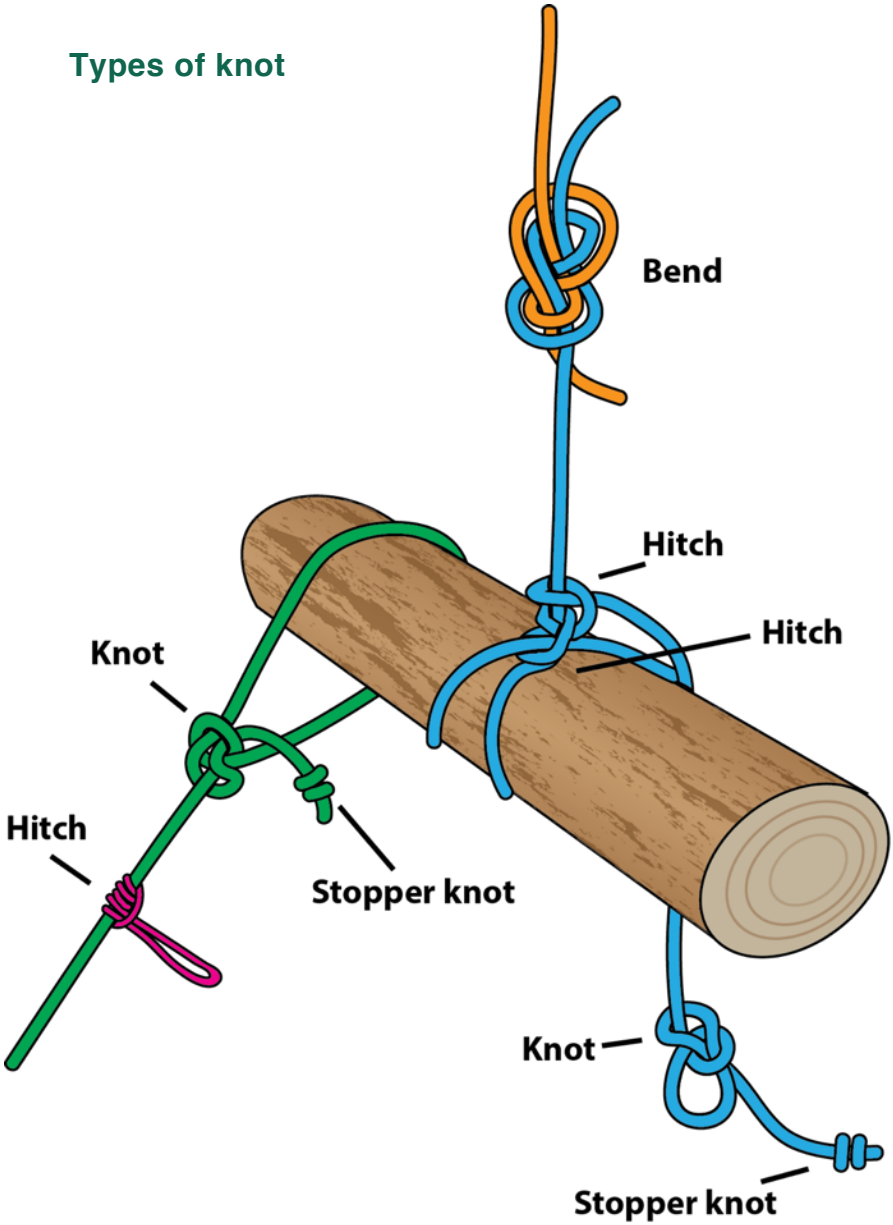
Types of knot



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Knots

Knots are used to form a fixed eye in the rope, or to secure a rope around an object. If the object is removed, the knot will usually remain.

Stopper knot

Stopper knots are used to prevent the end of a rope slipping through an adjustor, or to prevent the end of a rope slipping through a knot.

Hitches

Hitches are used to bend a rope to or around an object, such as timber or to another rope when climbing.

Bends

Bends are used to join the ends of two ropes, or to join both ends of a rope to each other to form a fixed loop.

Friction hitches

Friction hitches are a specialised category of hitch, where the hitch can be moved along the object it is tied to. Friction hitches are tied onto other ropes as part of climbing or rigging systems.

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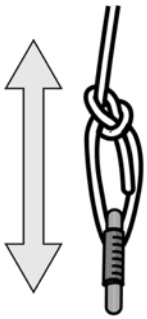
Tying knots

TIE

- **Tie** the knot and attach it to any structure or hardware.
- Make sure every part of the rope is in the correct place.
- With some knots, it is easier to inspect them before pulling them tight (e.g. a Flemish bend).

DRESS

- **Dress** the knot by tightening it until it looks correct.
- Check that every part is correctly aligned and 'sitting' in the right place. It should already look like a completed knot.



SET

- **Set** the knot by loading it.
- The different parts of the rope will only fully tighten into their final positions when the knot is 'set'.
- With some hitches that move on the rope, this step allows you to ensure that the hitch is functioning correctly.

FINISH

- **Finish** the knot by inspecting it one more time after it has been loaded – make sure that any tie-off or backup has been installed and that the knot is fit for purpose.

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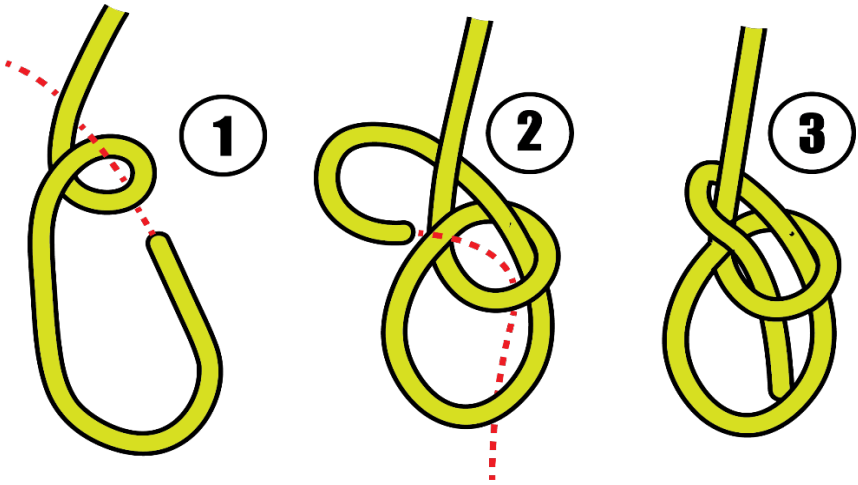
Knots

Knots are used to form a fixed eye in the rope, or to secure a rope around an object.

1: Bowline



- Also known as the standing bowline, bowlin or bowling knot.
- Possibly the most versatile arborist knot, commonly known as the 'king of knots' though becoming less common as a climbing knot.
- When tied correctly, as pictured above, the working end of the rope finishes on the inside of the loop.
- When tied with the tail on the outside of the loop it is called a **cowboy bowline** or **left-handed bowline**.
- 'Right-handed is always the more secure variation. Whether there is a difference in the breaking strain is still undecided.' (Dirk Lingens, *Tree Climber's Knotbook*, p. 206).
- Because the tail end 'creeps' when the knot is loaded and unloaded it must be tied off or backed up with a stopper knot if used for life support.

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Bowline	
uses	an end-line attachment knot, used in many rigging and climbing systems
approximate strength	60% to 75% of rope strength
cinching	no
life support	only with backup or tie-off
rigging	yes
backup required	yes if used for life support (see bowline with tie-off)
tail creeps	yes
minimum tail length	5 x rope diameter, but tail must be tied off or backed up with stopper knot for life support
ease of untying	very easy even after heavy load

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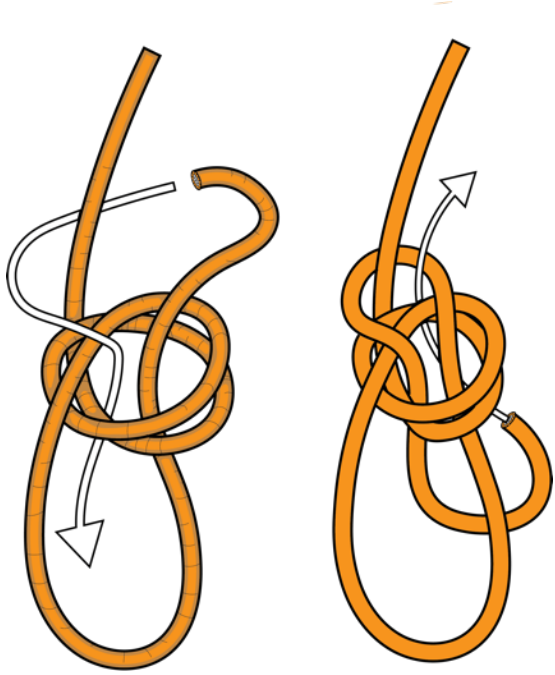
Double bowline

- The bowline is not suitable for an end-line life-support knot without a **tie-off** or **backup knot** – as noted above, the tail can creep through the knot when it is loaded and unloaded.
- A **double-overhand knot** or similar can be used in the tail of the rope as a backup.
- A tie-off such as the Yosemite tie-off can be used. There have been a number of incidents relating to the incorrect use of the Yosemite tie-off; it is easy to attach to the wrong loop in a sloppily tied or unfinished knot.
- The image below shows a **double bowline**. This version of the knot is more secure and less prone to creep.

  The right-hand image below shows how to tuck the tail back through the knot. Tucking the tail in this manner prevents creep and does not require an additional backup knot.



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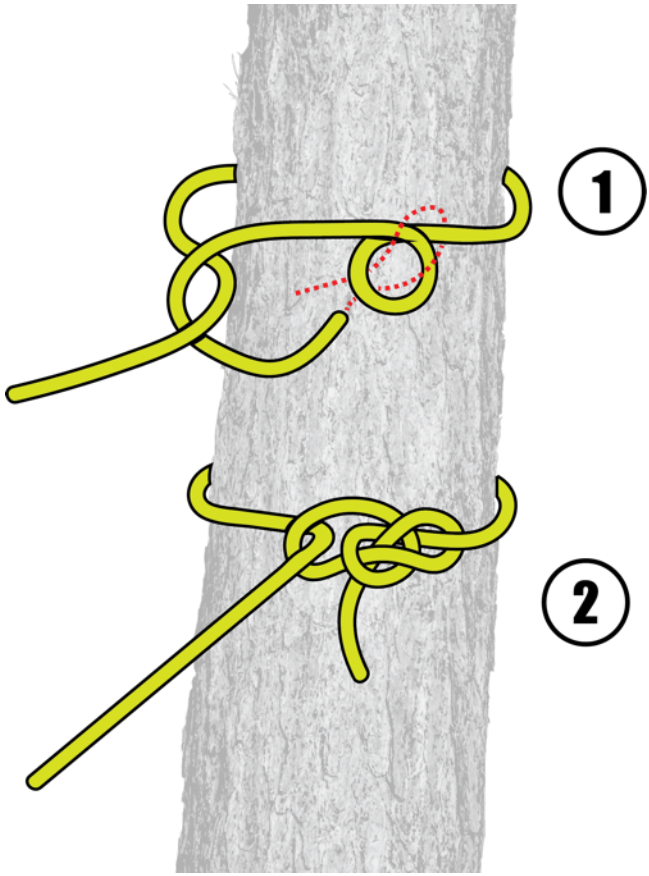
2: Running bowline

- Running bowlines can allow rigging and tag lines to be set at a distance by throwing the rope through a union and then pulling the running bowline tight.
- Running bowlines (when the bowline is backed up with a stopper knot or tied off) are also a secure way to anchor a life-support line for climbing.
- Often used with a **half-hitch pre-knot** (see image on following page).



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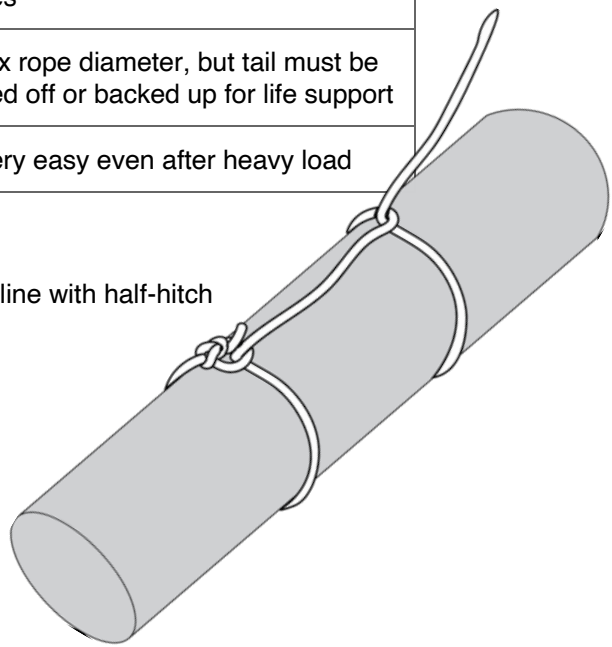
Running Bowline	
uses	attaching ropes to branches for rigging or climbing
approximate strength	64% to 68% depending on branch diameter
cinching	yes – to structure; can loosen when unloaded
life support	yes – with tie-off on bowline
rigging	yes
backup required	yes if used for life support (see Bowline with tie-off)
tail creeps	yes
minimum tail length	5 x rope diameter, but tail must be tied off or backed up for life support
ease of untying	very easy even after heavy load



Running bowline with half-hitch pre-knot

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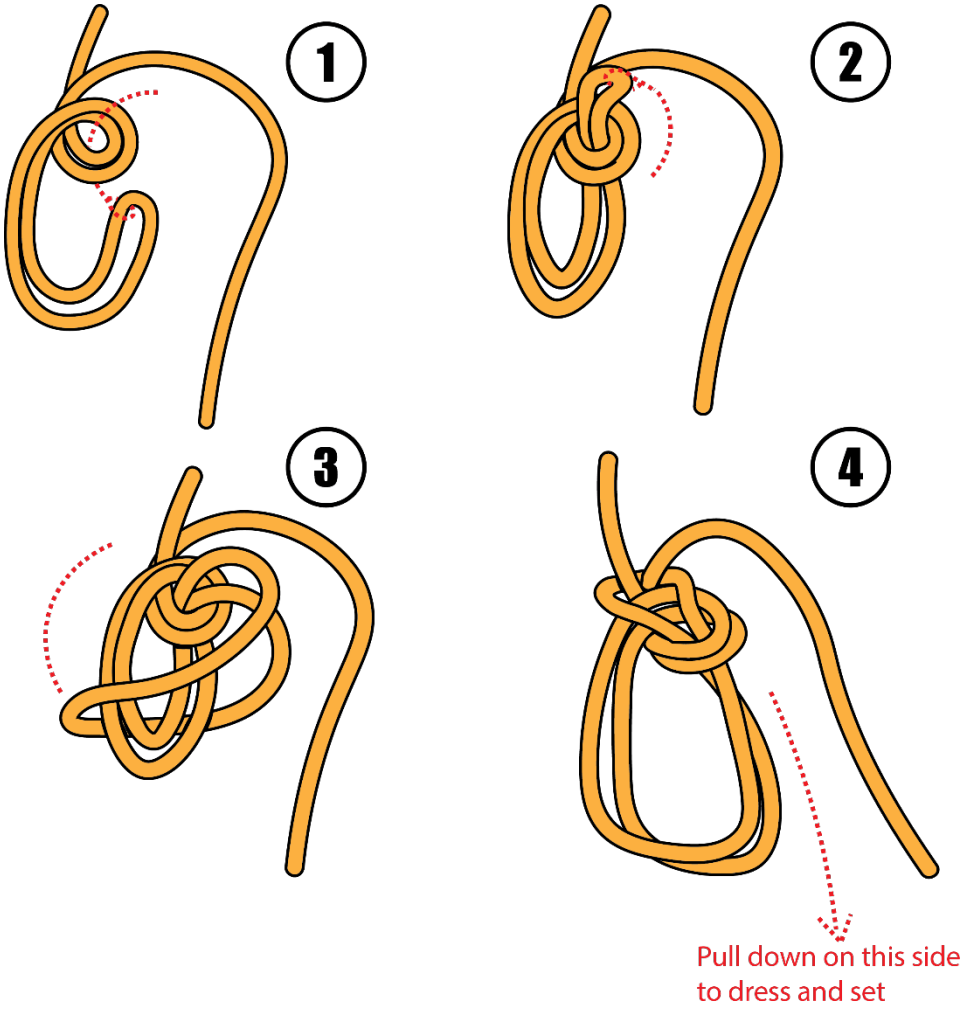
3: Bowline on a bight

- Solid, easy to tie in-line knot.
- Cannot be tied ‘around’ an object - if this is required then use the alternate version ‘bowline tied with a bight’ pictured on following page.



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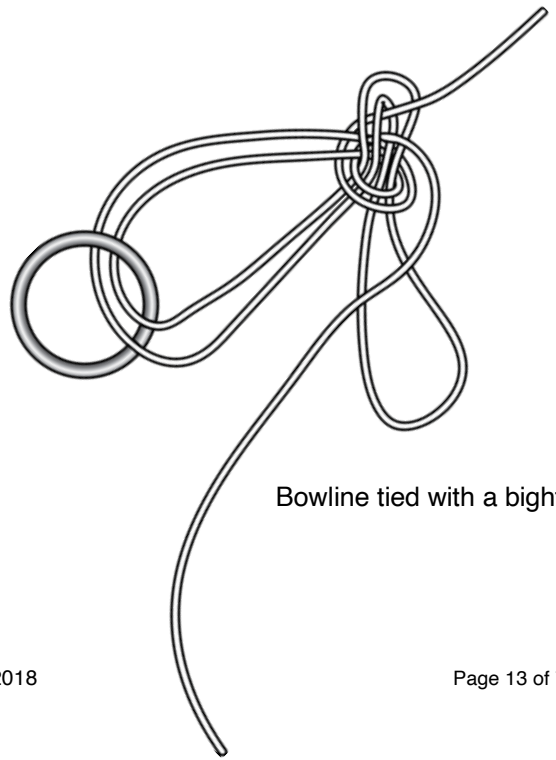
Bowline on a bight	
uses	in-line attachment knot
approximate strength	60% to 75% of rope strength
cinching	no
life support	yes
rigging	yes – more frequently used for pulling
backup required	no
tail creeps	no
minimum tail length	–
ease of untying	very easy even after heavy load



Bowline tied with a bight

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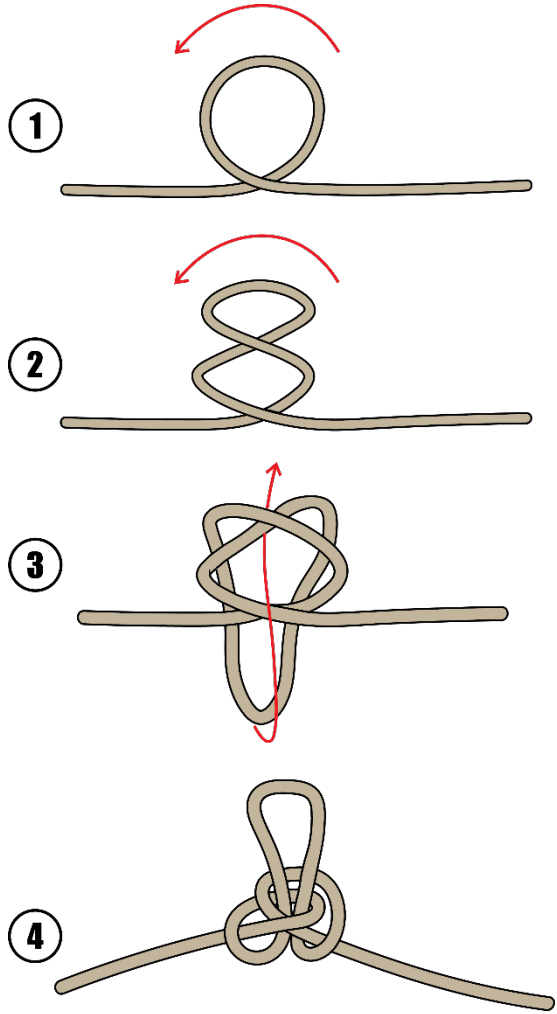
4: Alpine butterfly

Butterfly knot: tying method 1

- An excellent mid-line knot for integration into many different climbing systems.
- Comparatively weak – may decrease rope strength by over 50%.
- Can be confusing to tie at first.
- Can be loaded multi-directionally.
- Sometimes used as a 'running alpine butterfly' (see page 16) to secure canopy anchors, or to choke lines against wide stems for access via footlocking techniques.



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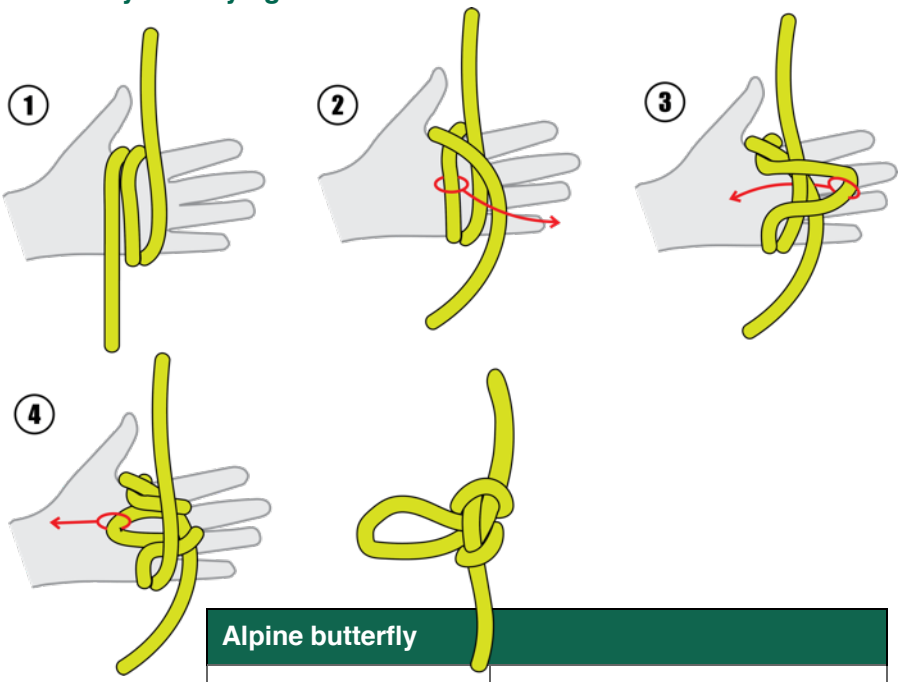
Butterfly knot: tying method 2



Alpine butterfly	
uses	multi-directional in-line knot
approximate strength	45% to 48% of rope strength
cinching	no
life support	yes
rigging	yes, but weak and binds up
backup required	no
tail creeps	no
minimum tail length	–
ease of untying	difficult after heavy loads

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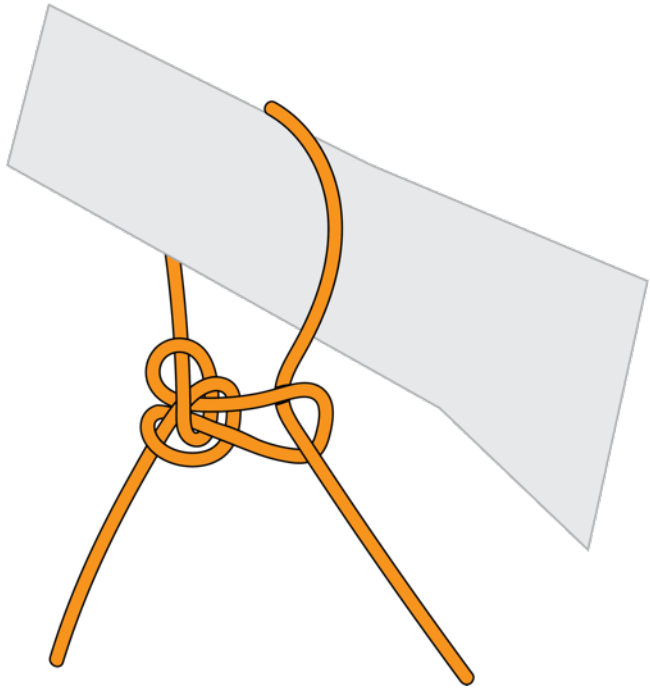
Running alpine butterfly



- The running alpine butterfly (shown above not dressed or set) is tied exactly like the normal alpine butterfly, and then the working end of the line is fed through the eye of the knot.
- By pulling on the working end, the system can be choked against a branch or stem as shown, to anchor one side or to bring both sides of the rope closer together.

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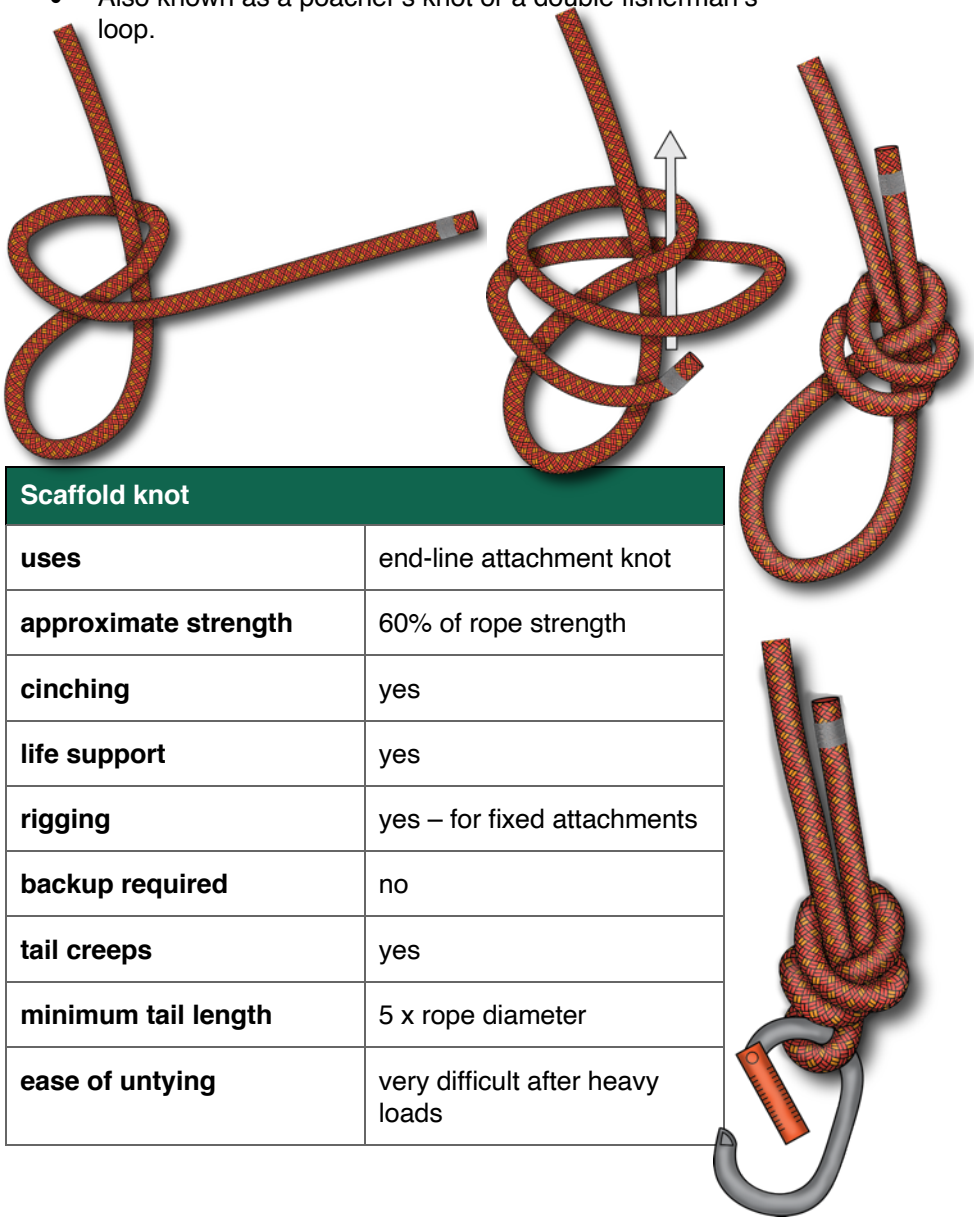
5: Scaffold knot

- Also known as a poacher's knot or a double fisherman's loop.



Scaffold knot	
uses	end-line attachment knot
approximate strength	60% of rope strength
cinching	yes
life support	yes
rigging	yes – for fixed attachments
backup required	no
tail creeps	yes
minimum tail length	5 x rope diameter
ease of untying	very difficult after heavy loads

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6: Figure-8 loop

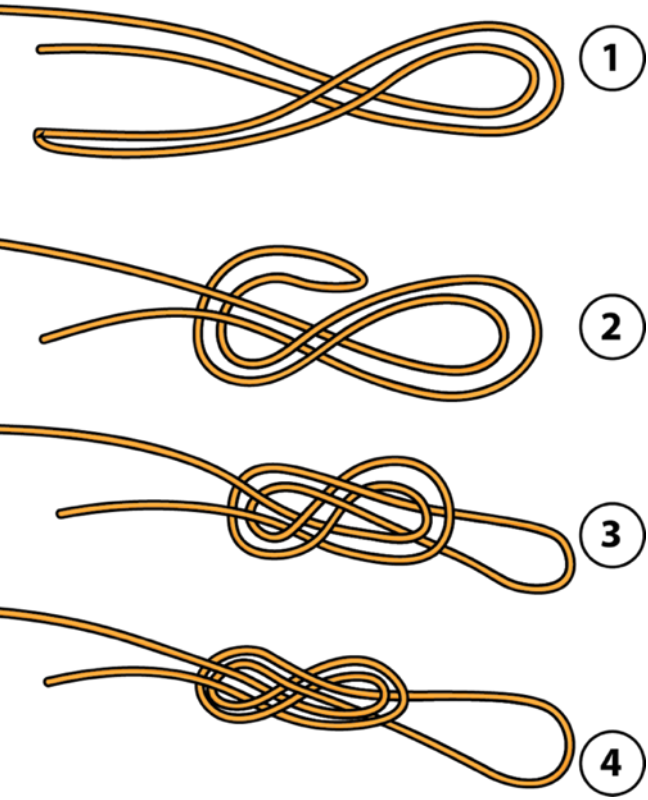

Figure-8 loop	
uses	stable in-line or end-line knot
approximate strength	80%
cinching	no
life support	yes
rigging	yes
backup required	no
tail creeps	yes
minimum tail length	5 x rope diameter
ease of untying	may bind if used for rigging

- Makes a stable eye that is stronger than a bowline and can be loaded in multiple directions.
- It can be tied as an end-line knot, midline by using a bight (as shown above) or around an object by retracing the knot (see following page).

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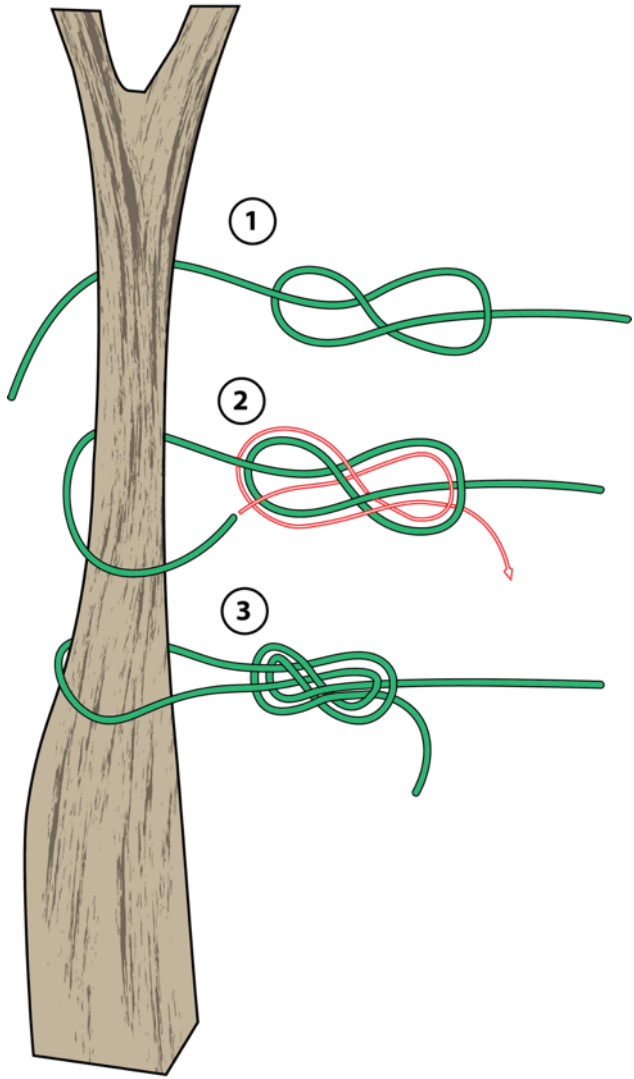
Retraced figure-8 loop

- Can also be tied around an object. Begin by tying a figure-8 in the line as shown, then pass the running end around the object.
- The running end can then be **retraced** back through the figure-8 knot, making sure that both sides of the line remain adjacent throughout the knot.
- Note that a similar method of tracing the end of a rope through a figure-8 knot can be used to join two ropes – this is called the **Flemish bend** or **retraced figure-8 bend**.



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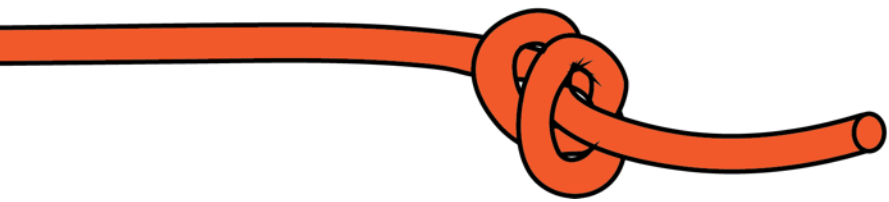
Stopper knots

Stopper knots are used to prevent the end of a rope slipping through an adjustor, or to prevent the end of a rope slipping through a knot.

7: Double-overhand knot

Also known as a **barrel knot**.

- A simple, secure end-line stopper knot.
- Opposing double-overhands are used to make the double-fisherman's loop.



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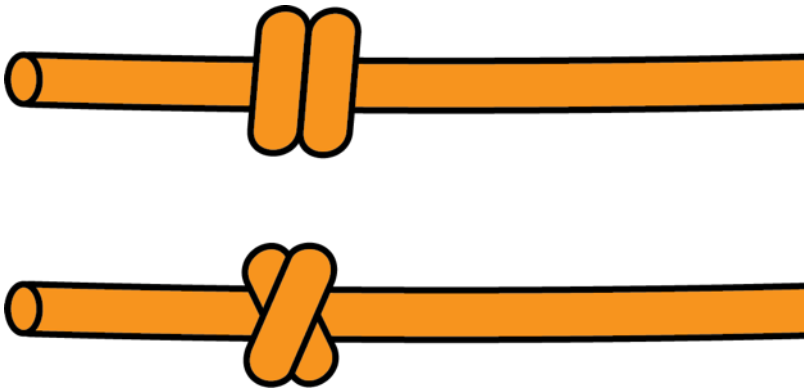
Double-overhand knot or barrel knot	
uses	end-line stopper knot
approximate strength	not directly loaded; will reduce strength
tail creeps	yes
minimum tail length	5 x rope diameter
ease of untying	will bind if loaded



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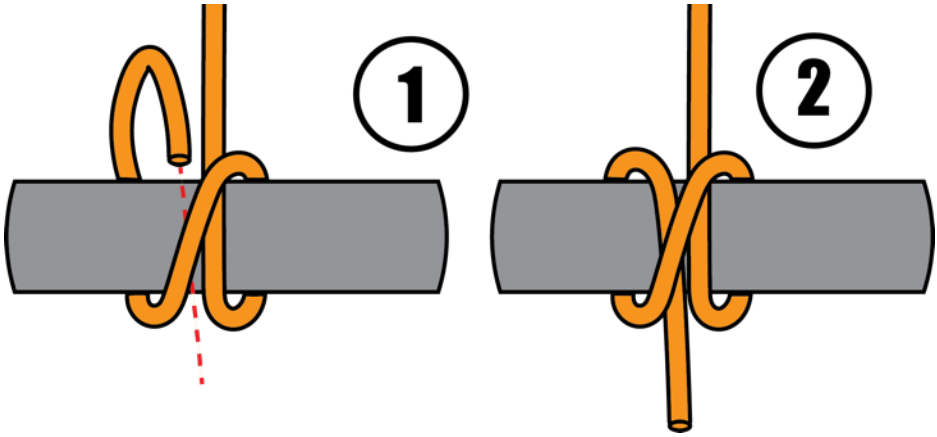
Hitches

Hitches are used to bend a rope to or around an object, such as timber or to another rope when climbing.

8: Clove hitch



- Second only to the bowline (knot #1) in versatility.
- Commonly used as an **end-line attachment knot** in many rigging situations such as attaching limbs to be lowered (must be backed up in this situation – see below).
- Also used to send up items to a climber, where the items do not have a karabiner attached such as a drink bottle, hand saw, etc.
- If used as an end line attachment knot it must be **backed up** with a **minimum of two half-hitches** to stop this hitch from potentially rolling out (see following page).
- Can be tied **mid-line.**
- Can be tied by bending two loops, inverting and 'dropping over' an object, or by passing the object through to tie an in-line clove hitch.

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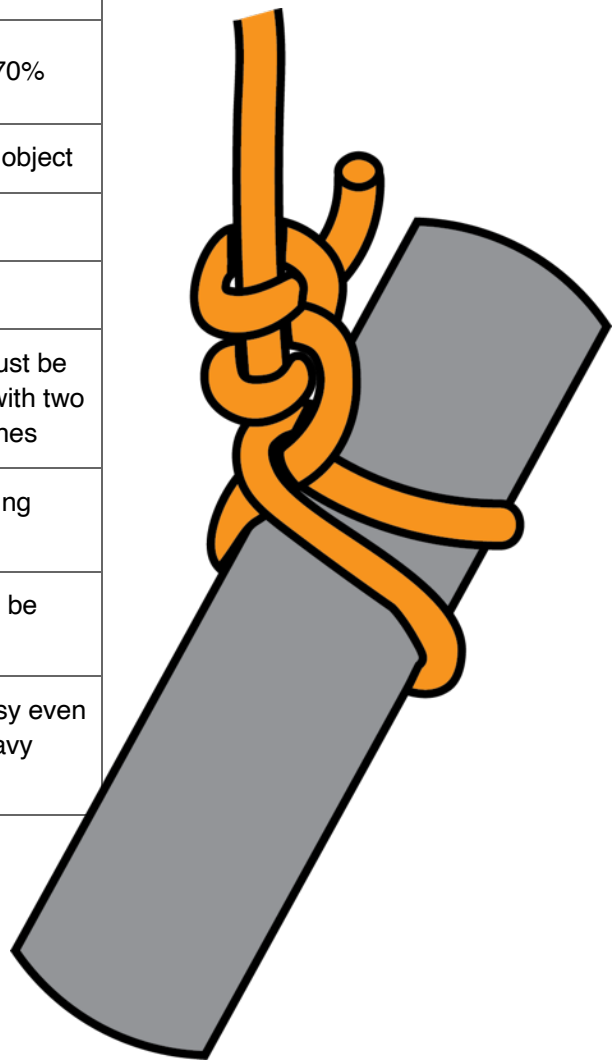
Clove hitch	
uses	many rigging and climbing uses
approximate strength	60% to 70%
cinching	yes – to object
life support	yes
rigging	yes
backup required	yes – must be tied off with two half-hitches
tail creeps	yes, during rollout
minimum tail length	tail must be tied off
ease of untying	fairly easy even after heavy load



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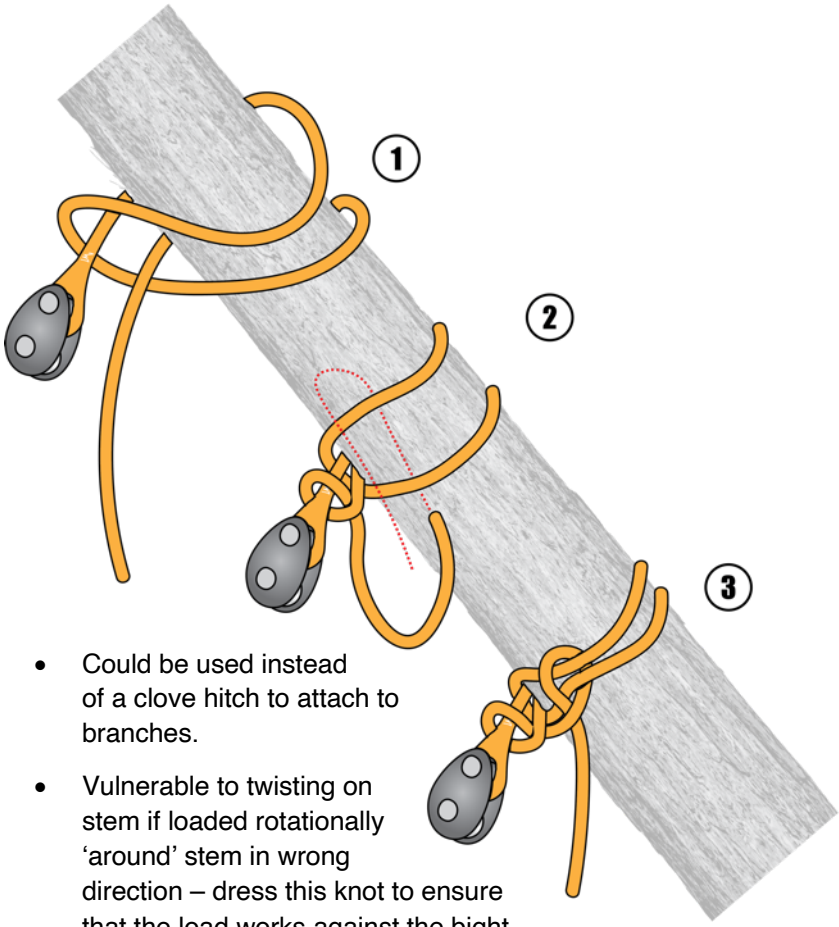
9: Cow hitch with a better half



- Could be used instead of a clove hitch to attach to branches.
- Vulnerable to twisting on stem if loaded rotationally ‘around’ stem in wrong direction – dress this knot to ensure that the load works against the bight.
- Quick to tie and untie.
- A good choice for attaching hardware such as rigging blocks or pulleys.

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Cow hitch with a better half	
uses	attachment knot for rigging
approximate strength	57% to 76%
cinching	yes – to object
life support	uncommon
rigging	yes
backup required	the ‘better half’ is the backup
tail creeps	yes, under load
minimum tail length	heavy loads can pull through lots of tail
ease of untying	very easy

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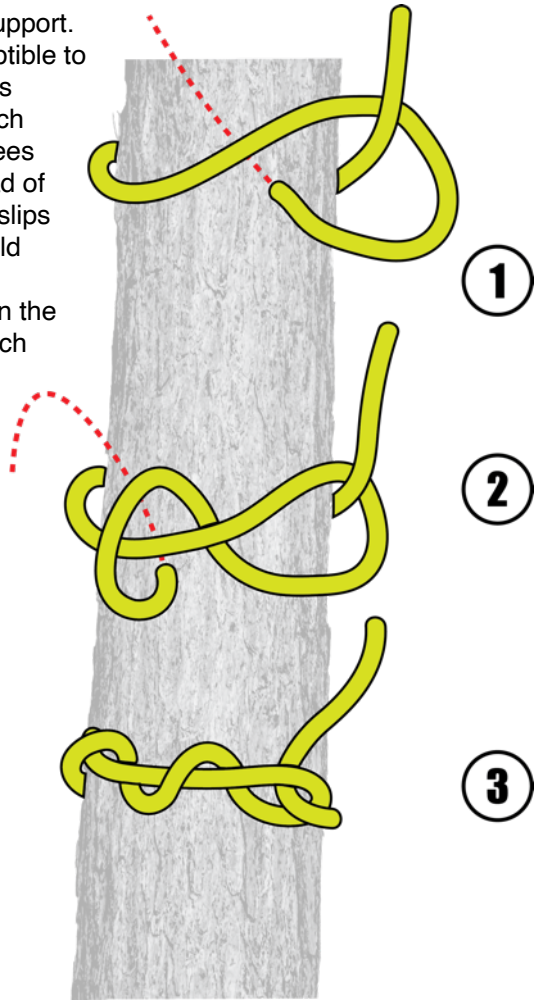
10: Timber hitch

- Very easy knot to tie and is very secure under load; easy to untie and does not jam. The timber hitch also uses minimal rope.
- It is important to have **at least four wraps** around the 'standing part' of the hitch; they need to be wrapped at least halfway around the circumference of the object. A stopper knot can also be added to the running end. Turns must be against the trunk – they are less effective when not in contact, such as over a hollow or buttress.
- Not to be used for life support. This hitch is very susceptible to direction change and it is important to load the hitch vertically or ninety degrees (90°) to the bight, instead of horizontally. If the hitch slips sideways the wraps could bunch up severely compromising its hold on the object. Placing a half hitch below the timber hitch will reduce this risk.



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Timber hitch	
uses	attachment knot for rigging
approximate strength	highly variable depending on trunk diameter
cinching	yes – to object
life support	no
rigging	yes
backup required	no
tail creeps	if tied with insufficient wraps
minimum tail length	–
ease of untying	very easy

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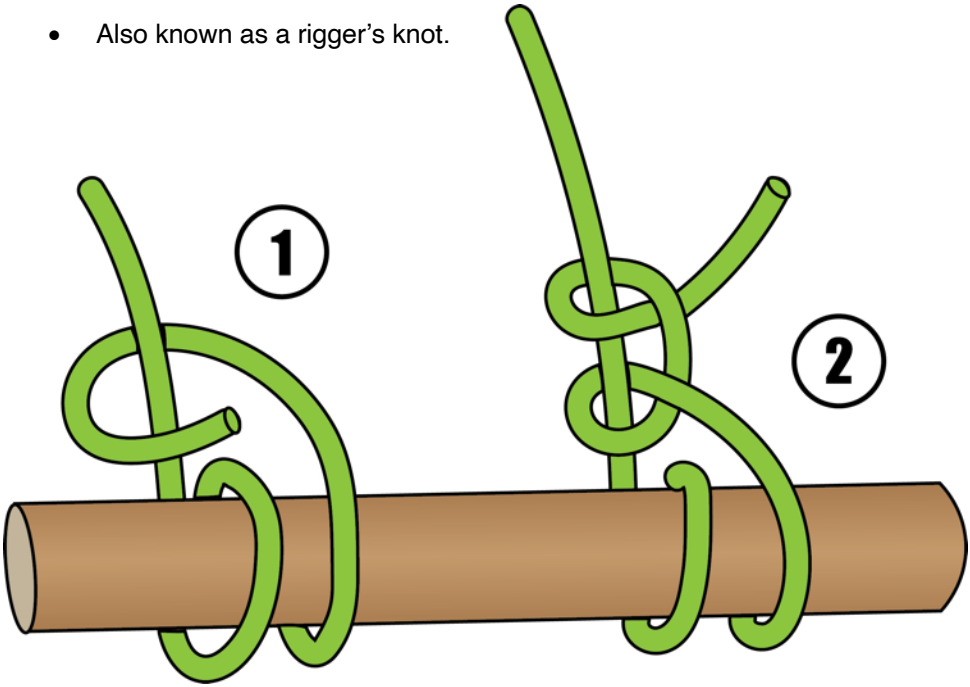
11: Round turn and two half-hitches

- Also known as a rigger's knot.



- Technically a running knot rather than a hitch, but included here because it serves a similar work function to neighbouring hitches.
- An excellent knot for heavy loads – the turns applied to the timber will reduce the force applied on the hitches. Taking additional turns will make the knots stronger and easier to untie.
- With sufficient turns, this knot can be untied under load.

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Round turn and two half-hitches	
uses	attaching ropes for rigging or climbing
approximate strength	very strong, particularly on large diameter logs or with extra turns
cinching	yes – to object
life support	yes – with tie-off or stopper knot
rigging	yes
backup required	no for rigging, yes for life support
tail creeps	no
minimum tail length	5 x rope diameter
ease of untying	easiest knot to untie after load

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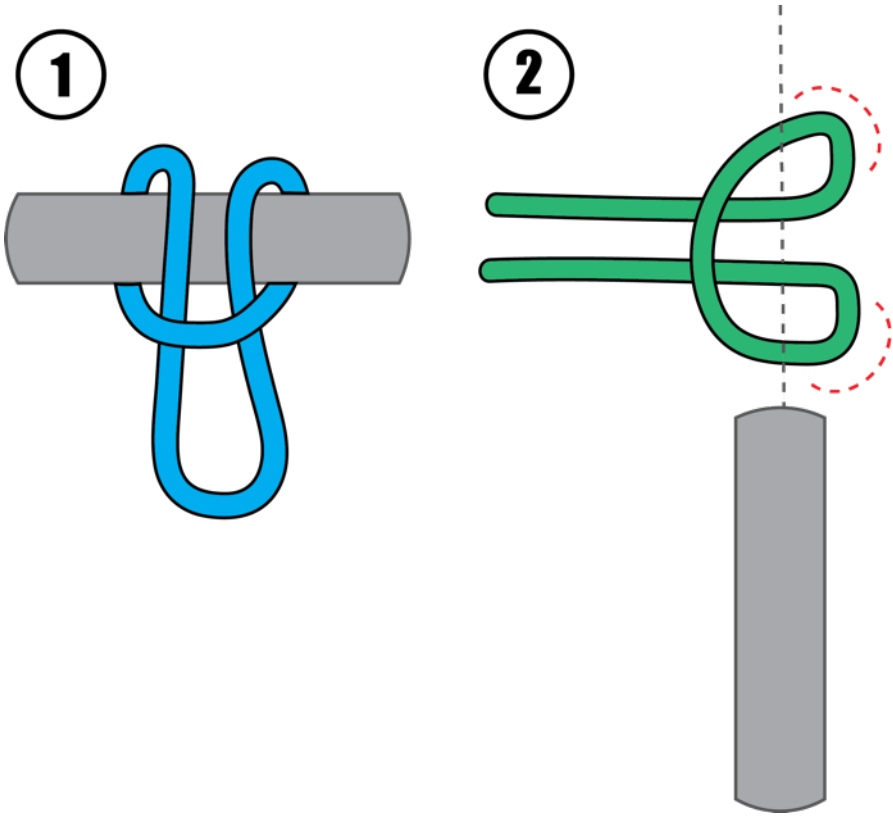
12: Girth hitch



- Useful way to quickly cinch a rope loop or webbing sling to an object.
- Much better than attaching a karabiner to a loop when used for life support – helps to maintain alignment and prevent cross-loading.
- Can be tied in several different ways:
    - method 1 – pass bight through loop around object
    - method 2 – make opposing loops in the rope and pass object through
    - method 3 – pass a bight of a rope or loop through an object and then around and over the object (on following page).

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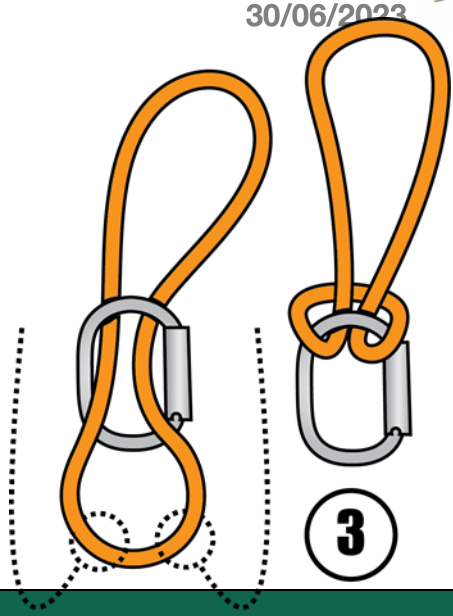

Girth hitch	
uses	cinching loops onto objects
approximate strength	depends on object diameter – weak if used to join 2 slings
cinching	yes
life support	yes when used to cinch suitable loop
rigging	yes
backup required	no
tail creeps	–
minimum tail length	–
ease of untying	easy if object removed – can bind tightly under load

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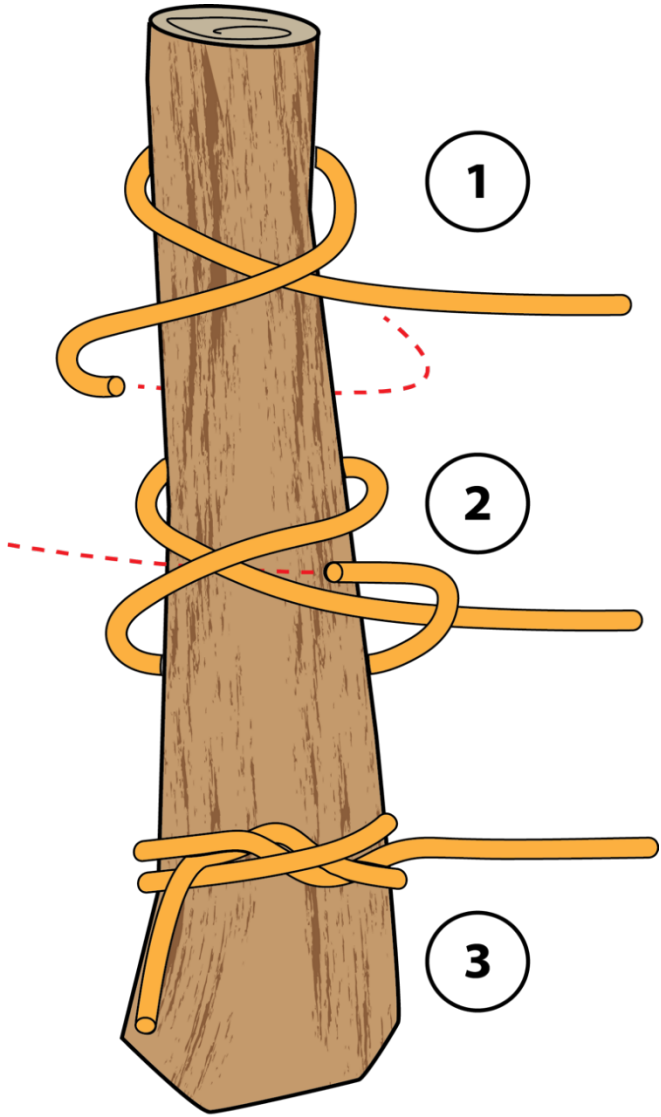
13: Constrictor knot

- A modified version of the clove hitch, known to be one of the most effective binding knots.
- Can be **extremely difficult** to untie after loading.
- Earliest record of this knot is a description called the *timmerknut* (timber knot) in the 1916 Swedish book *Om Knutar* (On Knots).
- Useful when a firm grip is required on a smooth object, such as when sending a drink bottle or pole saw up to a climber.
- More stable and dependable than a clove hitch.
- Must be backed up with half-hitches if used for life support.



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Constrictor knot	
uses	sending up equipment; tie-offs where security is the most important consideration
approximate strength	unknown
cinching	yes
life support	yes – with tie-off
rigging	yes but would bind
backup required	yes
tail creeps	yes
minimum tail length	5 x rope diameter
ease of untying	extremely difficult – may be impossible

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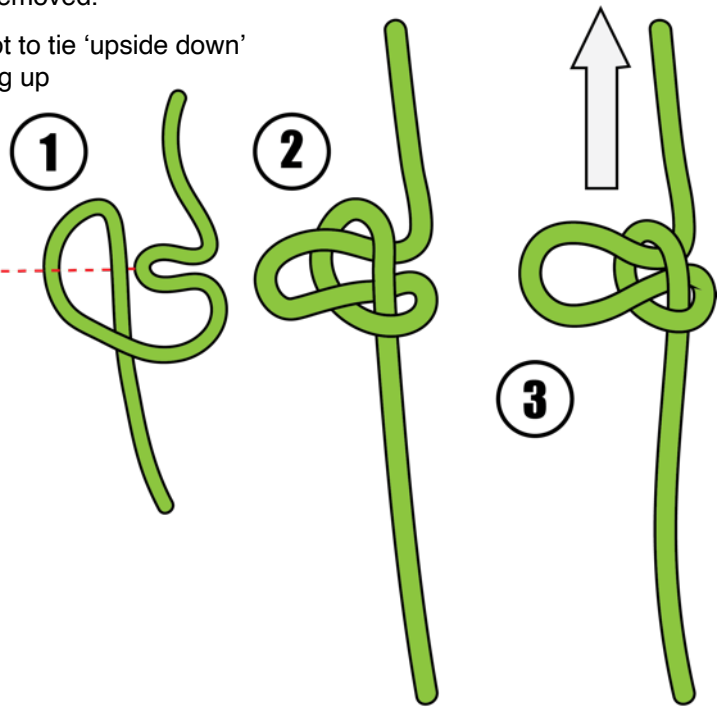
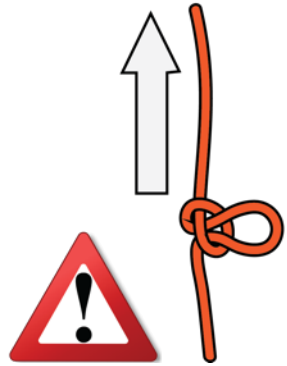
14: Marlinspike hitch

- Also known as a marline spike hitch.
- Quick, easy knot that can be tied with one hand, slips undone once attachment removed.
- Take care not to tie ‘upside down’ when sending up equipment – see tied knot in red below – because the tail can pull through.





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Marlinspike hitch	
uses	sending up equipment; quick attachments
approximate strength	not used for heavy loads
cinching	yes
life support	no
rigging	no
backup required	–
tail creeps	yes if tied in wrong direction
minimum tail length	mid-line knot
ease of untying	easy if object removed

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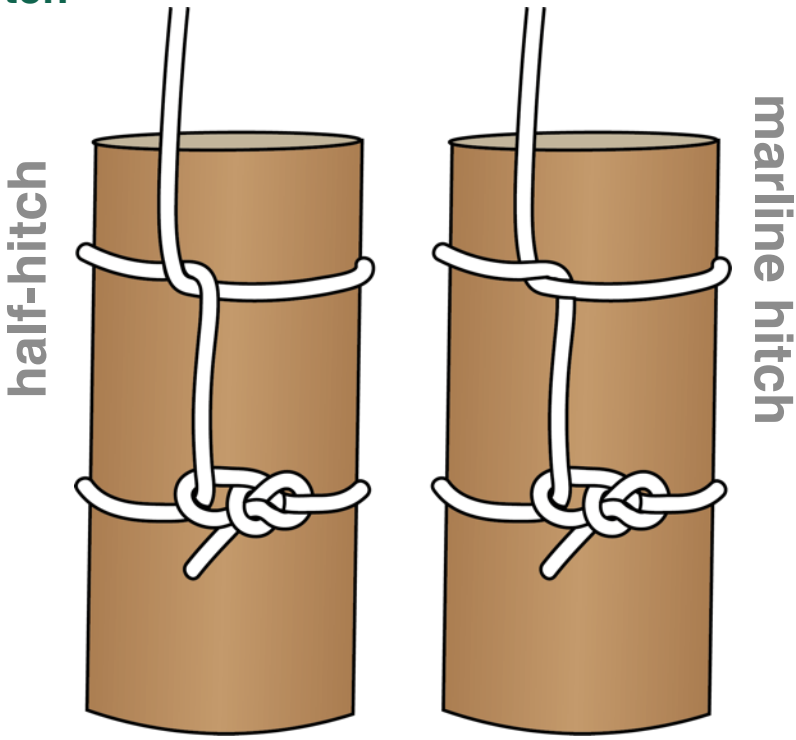
15: Pre-knots – half-hitch and marline hitch



- Both are supplementary hitches to protect a primary knot from slipping, to possibly improve strength by distributing load, or to change the balance point when rigging.
- Both pre-knots will become the weakest point in the configured system – the rope will usually break at the pre-knot rather than the primary knot.
- Rope should be pre-tensioned to avoid excessive heat from friction as tension is applied.

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Half-hitch and marline hitch	
uses	supplementary hitch in rigging systems
approximate strength	65% to 90% of rope strength
cinching	yes – to object
life support	as part of system with suitable primary knot
rigging	yes
backup required	no
tail creeps	–
minimum tail length	–
ease of untying	easy if object removed – half-hitch slightly easier to remove from log

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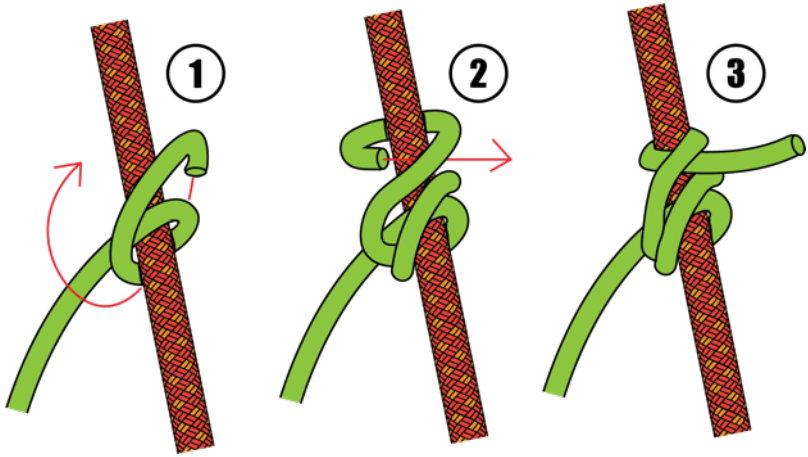
16: Rolling hitch



Rolling hitch	
uses	send up a rope or attach a rope to a log
approximate strength	will depend on use – varies
cinching	yes – to rope or object
life support	no
rigging	yes
backup required	yes
tail creeps	yes
minimum tail length	must use backup or tie-off – will roll out similar to clove hitch if not backed up with half-hitches
ease of untying	will bind if loaded

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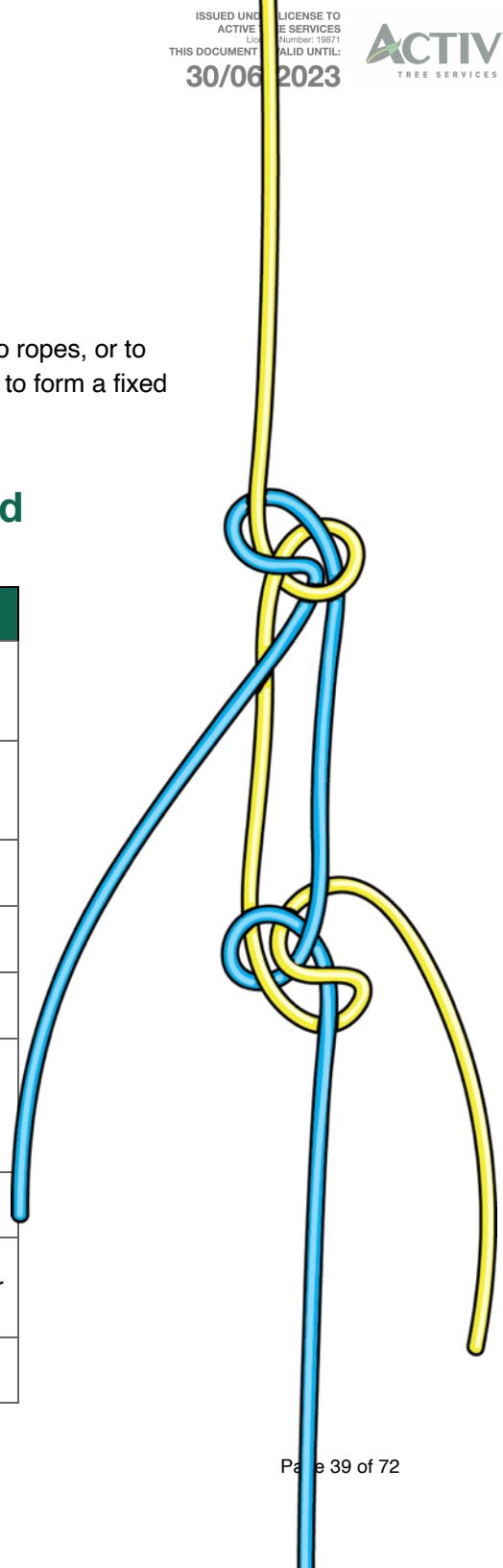
Bends

Bends are used to join the ends of two ropes, or to join both ends of a rope to each other to form a fixed loop.

17: Twin bowline bend

Twin bowline bend	
uses	Easy to untie bend
approximate strength	unknown, likely about 60%
cinching	–
life support	must be tied off
rigging	yes
backup required	yes, will loosen when unloaded – use tie-off
tail creeps	yes
minimum tail length	5 x rope diameter
ease of untying	easy



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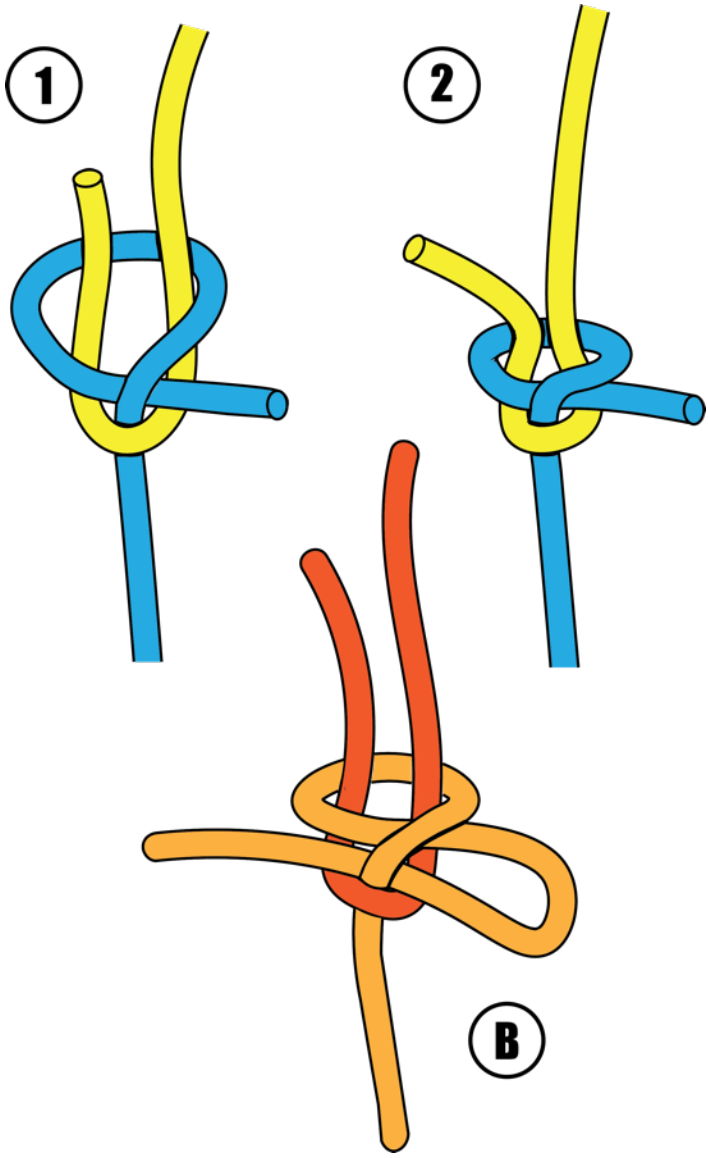
18: Sheet bend and slippery sheet bend



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Sheet bend and slippery sheet bend	
uses	joining ropes to send up to aerial worker
approximate strength	45% to 55%; prone to collapse before break
cinching	–
life support	no
rigging	no
backup required	not required for sending up ropes
tail creeps	no
minimum tail length	–
ease of untying	easy

- Quick, easy way to join two ropes to send up to an aerial worker - works with ropes of different diameters.
- Can be installed mid-line by making a bend at any point.
- Can be tied on a bight if required.
- Not for use for rigging or life-support – slips and rolls easily.
- Use a slippery sheet bend (B) to make it easier and quicker for an aerial worker to separate ropes even where significant rope weight is applied.

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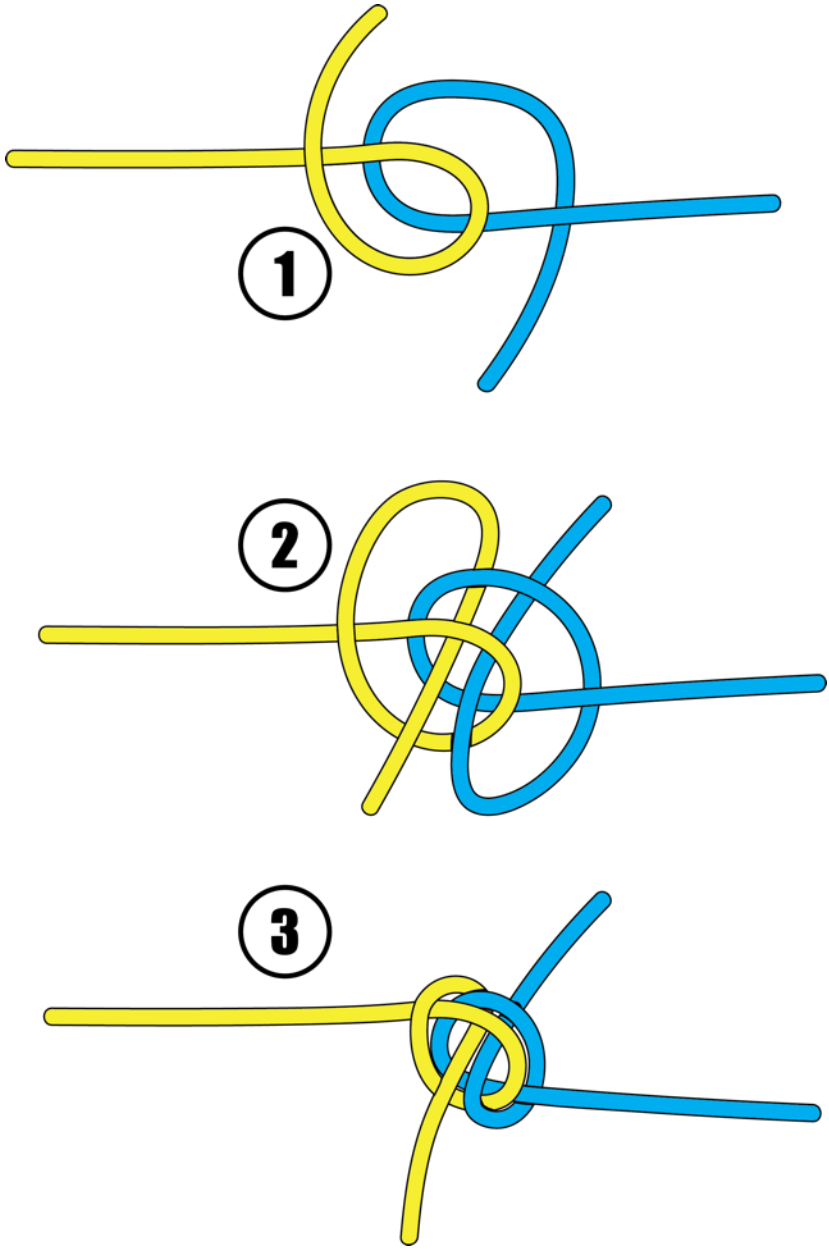
19: Zeppelin bend



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Zeppelin bend	
uses	joining ropes
approximate strength	varies depending on similarity of rope diameters
cinching	–
life support	yes
rigging	yes
backup required	yes if used for life support
tail creeps	yes if loaded and unloaded
minimum tail length	5 x rope diameter
ease of untying	easy

- A reasonably stable knot to join two ropes.
- Can loosen, particularly on stiff cordage when loaded and unloaded.
- Use backups or tie-offs if used for life-support.
- Looks very similar to several other bends such as the Ashley, hunter's and butterfly bends – all of which can be mistaken for this knot without close inspection.
- Very similar to an extremely weak knot called the 'evil imposter' – inspect this knot very carefully before using it.

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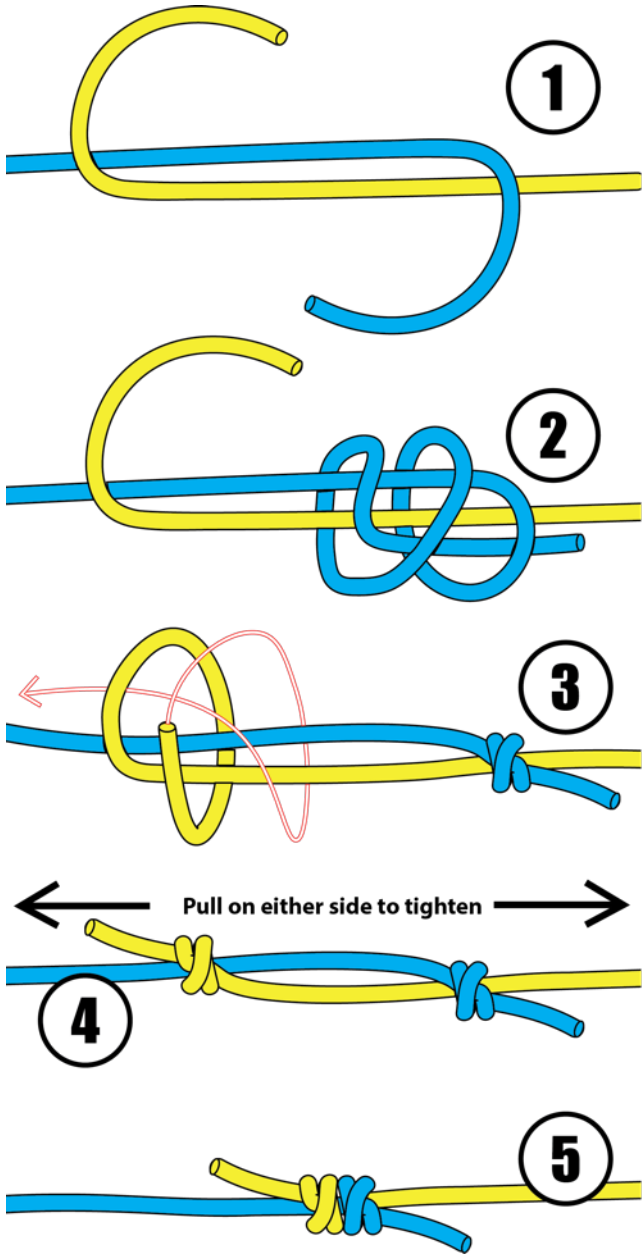
20: Double fisherman's bend



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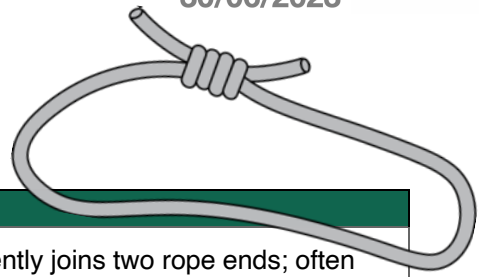

Double fisherman's bend	
uses	permanently joins two rope ends; often used when making prusik loops
approximate strength	74% to 80% of rope strength
cinching	no
life support	yes
rigging	not common for rigging use – binds
backup required	no
tail creeps	yes
minimum tail length	5 x rope diameter
ease of untying	very difficult – can be impossible after load

- Once loaded it can be very difficult to untie and is most commonly used in a permanent situation.
- Some modern high-modulus rope fibres are very slippery and can creep slowly, so it is advisable to 'whip' or stitch the tail of the knot to the standing part of the rope once loaded.
- Ensure LONG TAILS from either side of the knot to avoid problems.

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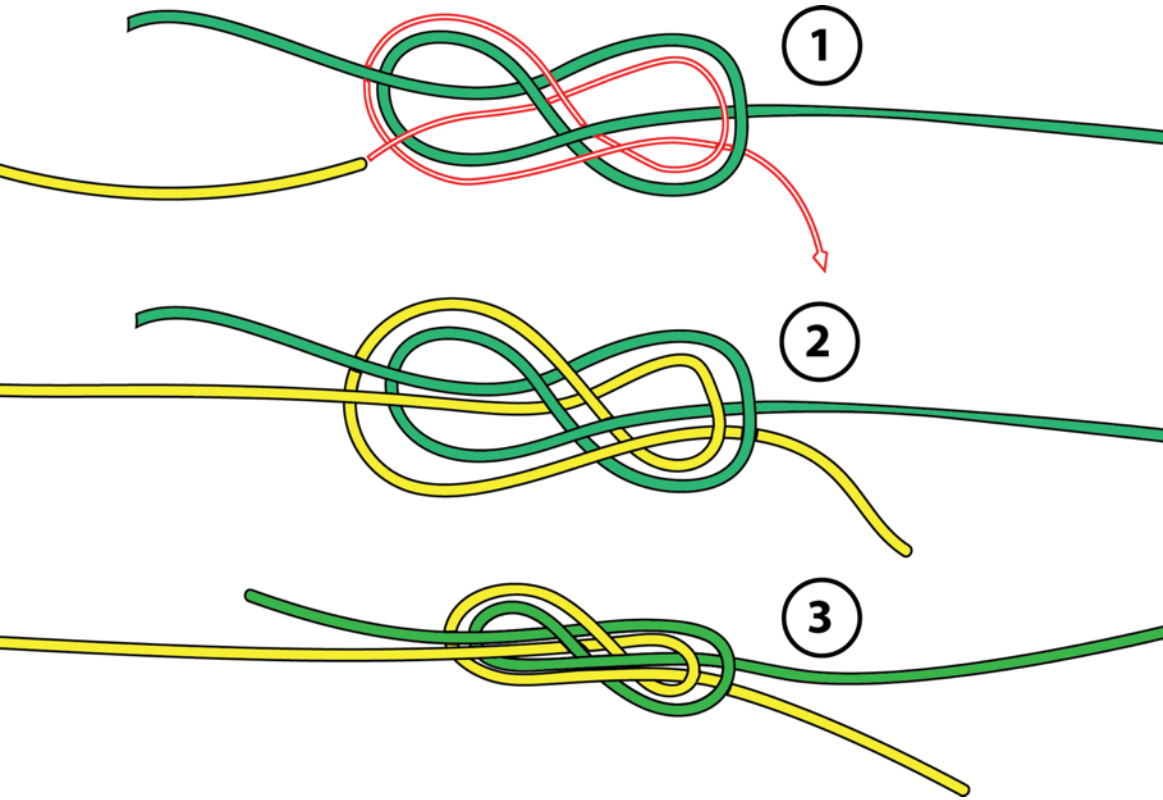
21: Flemish bend

- Also known as an interlaced figure-8 bend.



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Flemish bend	
uses	joining climbing ropes
approximate strength	70%
cinching	–
life support	yes
rigging	yes but may bind
backup required	no
tail creeps	yes if loaded and unloaded
minimum tail length	8 x rope diameter
ease of untying	easy after moderate load – will bind if used for rigging

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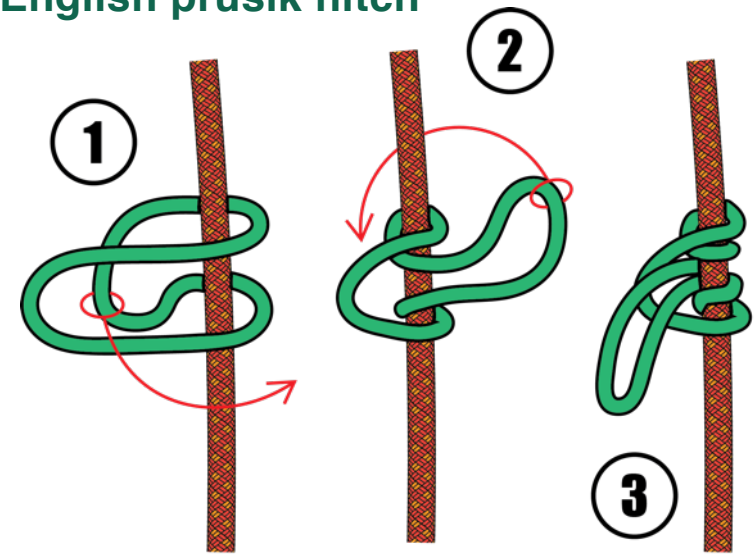
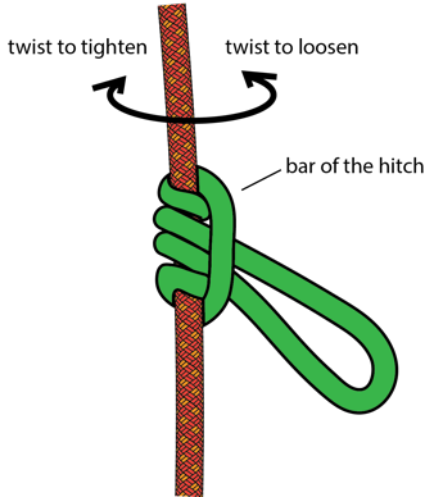
Friction hitches

22: English prusik hitch



- A good, simple hitch with many applications.
- Commonly used as a friction hitch for Moving Rope Technique or similar climbing applications.
- '4-wrap' version shown – can be tied with additional wraps if required. Friction will depend on variables such as rope construction, grip, diameter and climbing system used.



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English prusik hitch	
uses	climber's friction hitch
approximate strength	will usually slip on rope before breaking
cinching	yes
life support	yes
rigging	yes
backup required	no
tail creeps	no
minimum tail length	–
ease of untying	usually easy

- Called an ‘English prusik’ in Australia and New Zealand, but usually described as a ‘prusik hitch’ in most other countries.
- Named after an Austrian mountaineer called Karl Prusik.
- Often misspelled as prussik, prussick or prussic.

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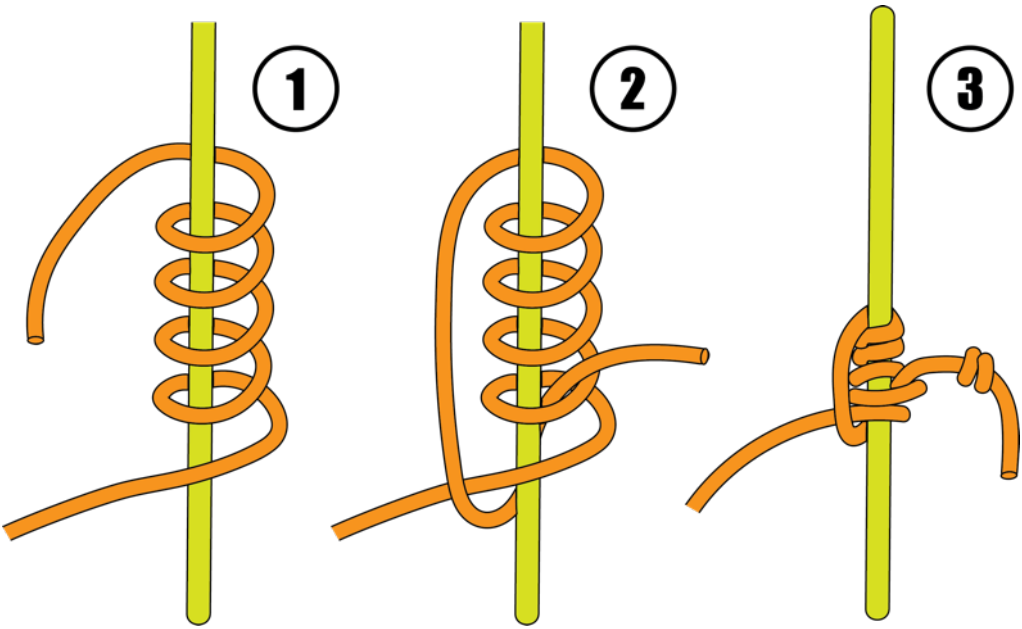
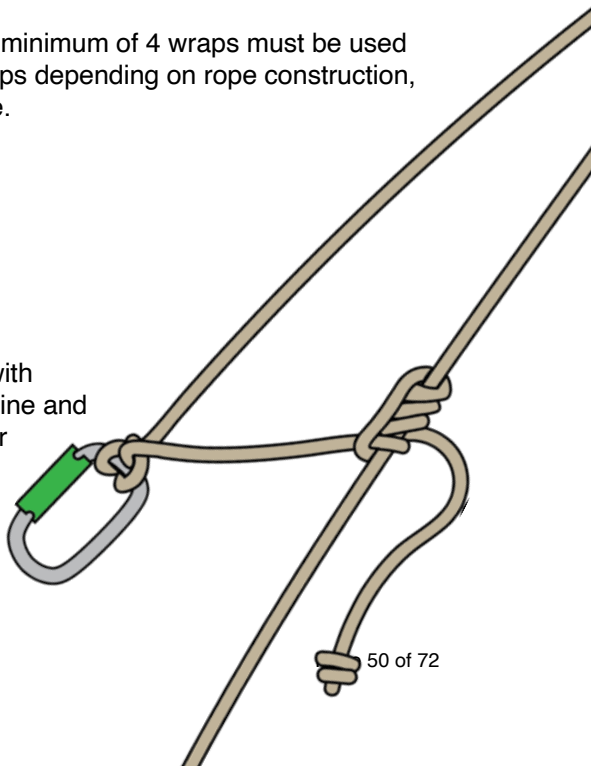
23: Blake's hitch



- 5 wrap Blake's hitch shown – a minimum of 4 wraps must be used but climbers may add more wraps depending on rope construction, diameter and hitch performance.



Closed climbing system made with Blake's hitch on tail of climbing line and clove hitch to attach to karabiner

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Blake's hitch	
uses	climber's friction hitch
approximate strength	will usually slip on rope before breaking
cinching	yes
life support	yes
rigging	yes – not common
backup required	yes – must use stopper knot or tie-off as shown
tail creeps	yes – can creep significantly
minimum tail length	must use backup or tie-off
ease of untying	usually easy

- A popular friction hitch for climbers, particularly in the United States of America.
- Easy to adjust the distance of the hitch from the climber; can be tied using the tail of the climbing rope (closed climbing system) if a second climbing system is needed.
- Not recommended for extended use as a primary climbing system if tied with tail of climbing rope – climbing rope will not be heat resistant.
- Wear/fraying is concentrated on the part of rope that is tucked under.

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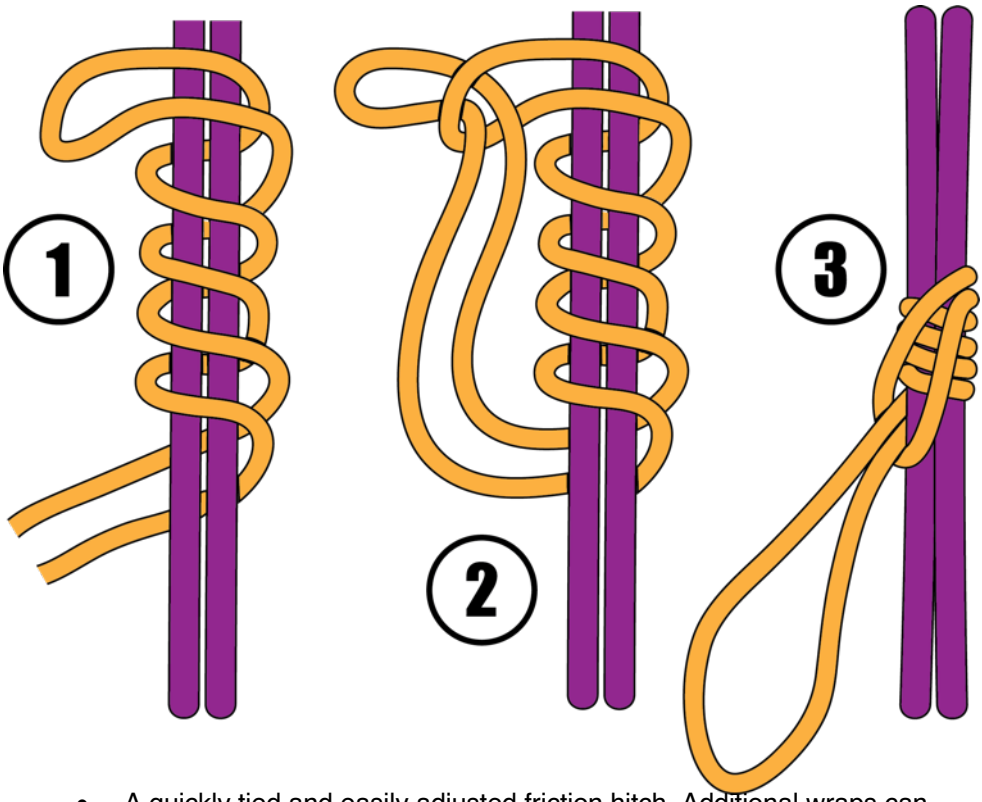
24: Klemheist



- A quickly tied and easily adjusted friction hitch. Additional wraps can easily be added if required.
- Can bind under load and may need to be loosened – not used as a work positioning hitch.
- Very easy to advance when unloaded. A good way to join mechanical advantage systems to rigging ropes.

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Klemheist	
uses	climbing and rigging friction hitch
approximate strength	will usually slip on rope before breaking
cinching	yes
life support	yes
rigging	yes
backup required	no
tail creeps	no – tied with loop
minimum tail length	tied with loop
ease of untying	usually easy

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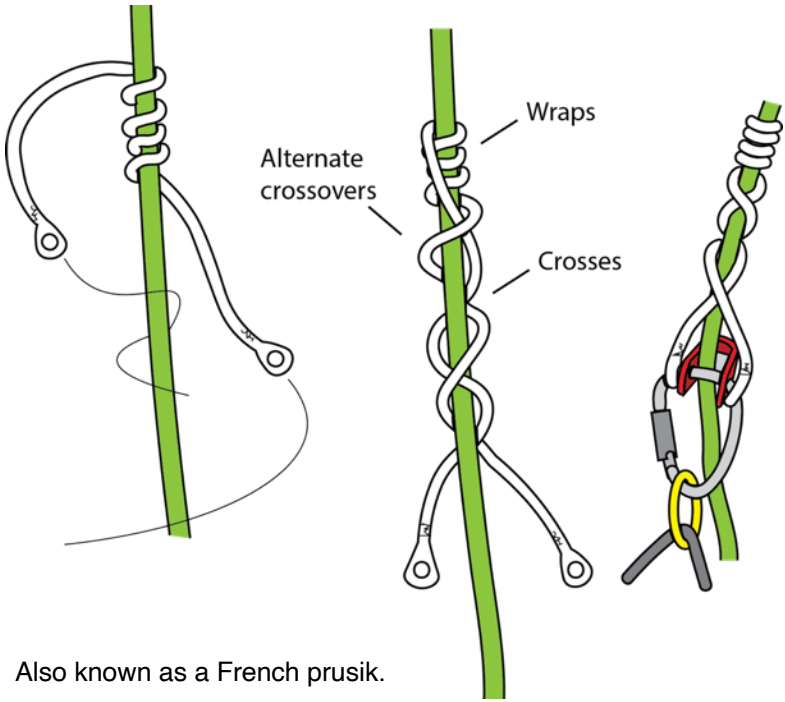
25: Valdôtain Tresse (VT)



- Also known as a French prusik.
- Very fast and smooth friction hitch. Works well on almost any rope type. Releases the rope and ‘fairleads’ the climbing line very well.
- Very simple to tie and can be ‘tweaked’ by the quick addition or subtraction of wraps or braids. Usually tied with 4 wraps and 3 crosses (see image above).
- One of the very few prusik hitches that holds securely on a rope that is already under load. When tied using a loop, this variation is called a Machard Tresse (MT) Prusik.
- Very fast! Can deform when unloaded; may need regular dressing during use.
- The French prusik only operates in one direction.

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Valdôtain Tresse / French prusik	
uses	climber's friction hitch
approximate strength	will usually slip on rope before breaking
cinching	yes
life support	yes
rigging	yes
backup required	no
tail creeps	–
minimum tail length	–
ease of untying	usually easy

The French Prusik is an unforgiving knot that has shortcomings with potentially fatal consequences. The primary shortcoming is that it sometimes fails to grab the rope if not tied exactly right. This typically occurs when not enough wraps and braids are taken with the cord. The length, diameter, and pliability of the cord also strongly influence how the hitch will perform. As with all knots, the French Prussik must not be integrated into a climbing system until the climber has mastered tying and operating it while on the ground.

(J Jepson, *The Tree Climber's Companion*, p. 84)

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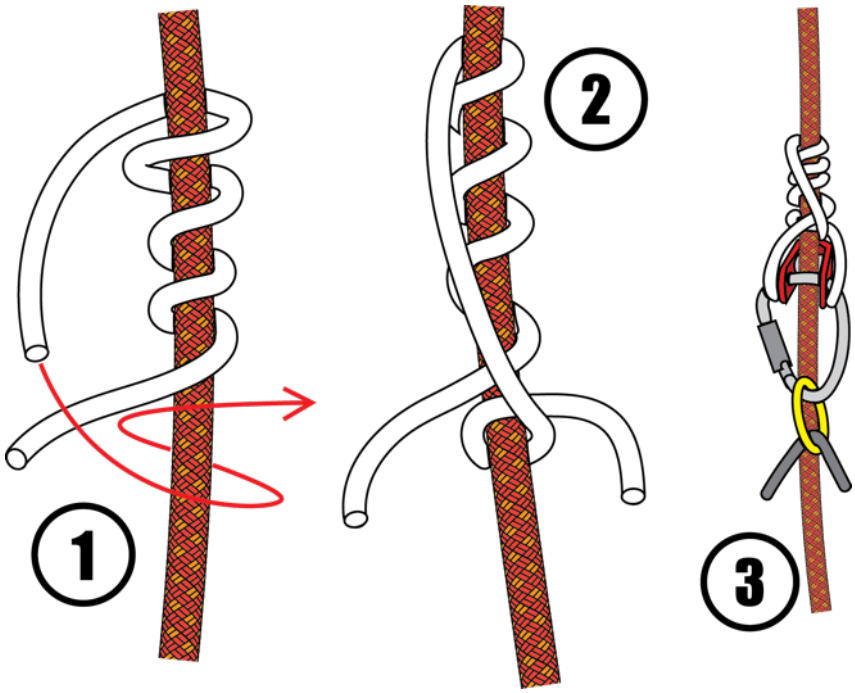
26: Distel hitch



- A compact and easily adjusted friction hitch. When tied well it has less setting distance (inefficiency) than the more popular Valdôtain Tresse (VT).
- Usually tied with a minimum of 4 wraps – 5 wraps shown above
- May need regular adjustment to function smoothly.
- Grabs more reliably than the ‘looser’ VT but may not tend as smoothly. Can bind easily.
- Named after its inventor, Ulrich Distel.

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Distel hitch	
uses	climber's friction hitch
approximate strength	will usually slip on rope before breaking
cinching	yes
life support	yes
rigging	could be used but not common
backup required	no
tail creeps	–
minimum tail length	–
ease of untying	usually easy

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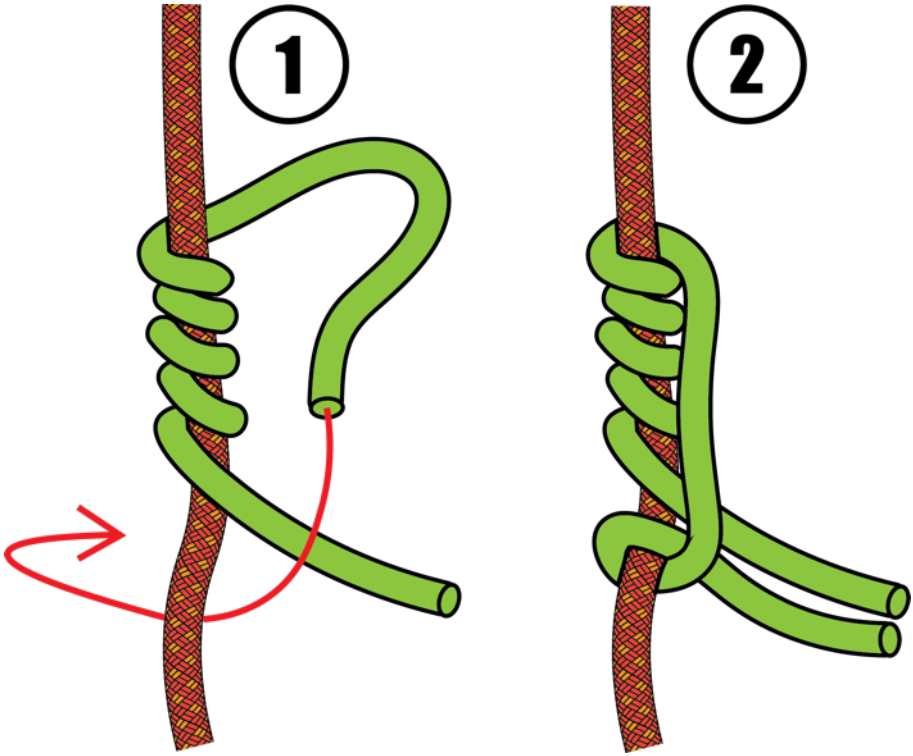
27: Schwäbisch hitch



- An asymmetric version of the English prusik, which operates more smoothly.
- Usually tied with a minimum of 4 wraps – 6 wraps shown above.
- Cannot be tied using a prusik loop – only eye-and-eye or split tail.
- In contrast to the other eye-and-eye hitches, both arms of the hitch cord leave the hitch on the same side of the primary rope – can be useful with some systems to prevent overloading of karabiners.
- Also known as a Swabian hitch.

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Schwäbisch hitch	
uses	climber's friction hitch
approximate strength	will usually slip on rope before breaking
cinching	yes
life support	yes
rigging	could be used but not common
backup required	no
tail creeps	–
minimum tail length	–
ease of untying	usually easy

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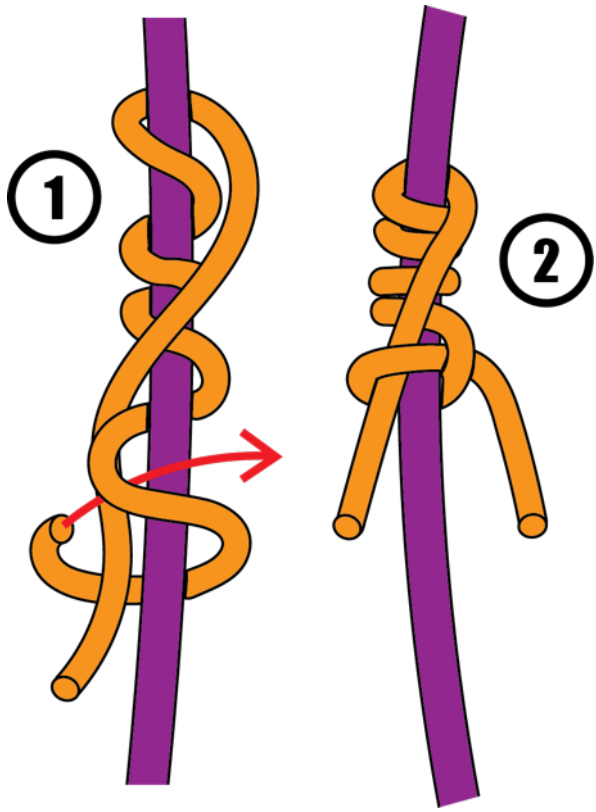
28: Knut



- A distel hitch variation that allows one-handed tending without need of a prusik-tending pulley.
- Usually tied with a minimum of 4 wraps – 5 wraps shown above.
- Invented and popularised by Knut Foppe.
- Pronounced ‘kuh-noot’ by most English-speaking arborists.

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Knut	
uses	climber's friction hitch
approximate strength	will usually slip on rope before breaking
cinching	yes
life support	yes
rigging	could be used but not common
backup required	no
tail creeps	–
minimum tail length	–
ease of untying	usually easy

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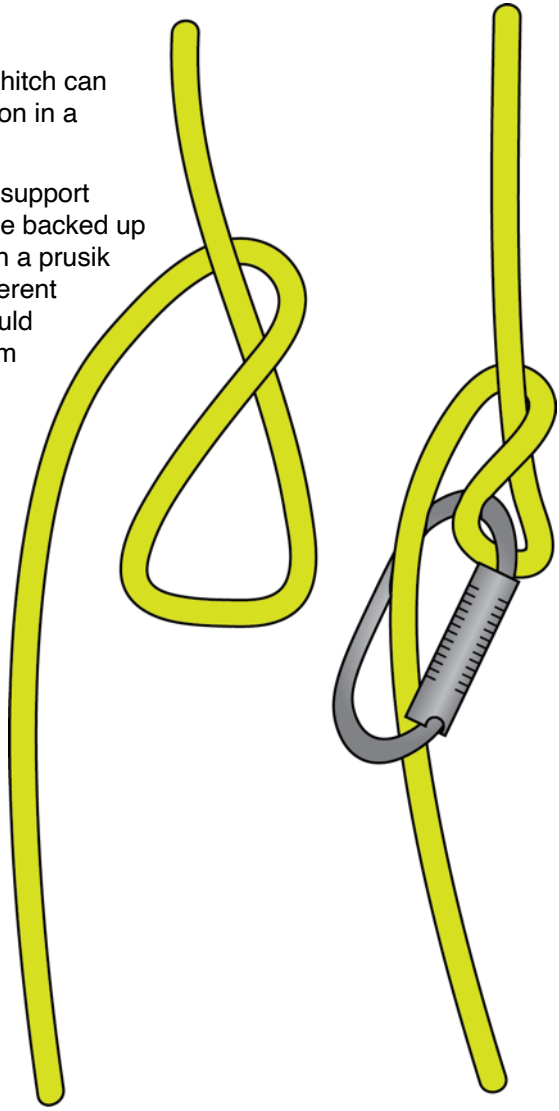
29: Munter hitch

- The Munter (or Italian) hitch can be used to control friction in a belaying system.
- If used as part of a life-support belay system, it must be backed up ('fail to safe') either with a prusik hitch, or by using a different locking system that would prevent the climber from slipping if the rope was released.
- The falling part of the rope must be against the spine of the karabiner (as shown) and not the gate to avoid rollout.
- Ensure that the karabiner used is suitable for this purpose and compatible with the rope diameter – oval karabiners may inhibit proper knot function on larger climbing rope diameters.



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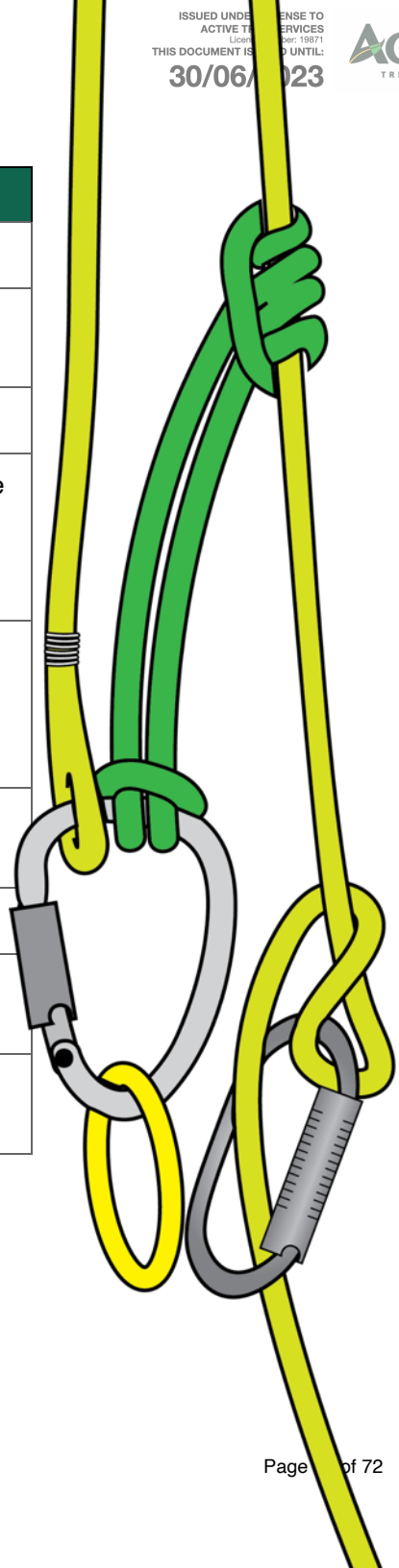
Munter hitch	
uses	belay hitch
approximate strength	–
cinching	yes
life support	no – must incorporate ‘fail to safe’ mechanism such as prusik hitch
rigging	could be used for additional friction on small pieces – would hockle rope
backup required	–
tail creeps	–
minimum tail length	–
ease of untying	very easy



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Using knots for tree work

Please see the following MISs for further details about how to use arborist knots for tree climbing and rigging:

- MIS305 Tree Climbing
- MIS303 Dismantling Trees
- MIS304 Aerial Rescue

Arborists use many different knots beyond those discussed in this book. Experience and tenure in industry will guide arborists in selecting knots that ‘work for them’.

Knots selected should have solid merit for the intended work task and should stand up to the rigours of testing and dependability, including critical analysis from experts.

When adopting knots that are not discussed in this document, ensure you understand their risks and weaknesses, and that the knots you select are appropriate for the intended work task.

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Appendix A: Knots chart

Knot	Page	Strength reduction*	Life support	Rigging
Alpine butterfly	14	52% to 55%	Yes	Binds
Blake's hitch	50	Slips	Yes	Uncommon
Bowline	7	26% to 53%	No	Yes
Bowline on a bight	12	–	Yes	Yes
Bowline with tie-off	8	26% to 45%	Yes	Yes
Clove hitch	22	25% to 45%	With tie-off	Yes
Constrictor knot	34	-	With tie-off	Binds
Cow hitch	24	17% to 38%	With tie-off	Yes
Distel hitch	56	Slips	Yes	Uncommon
Double fisherman's bend	44	21% to 26%	Yes	Binds
Double-overhand knot	20	30%	–	No
English prusik hitch	48	Slips	Yes	Yes
Figure-8 loop	18	80%	Yes	Uncommon
Flemish bend	46	70%	Yes	Yes
Girth hitch	30	–	Yes	Yes
Half-hitch	36	7% to 43%	–	–
Klemheist	52	Slips	Yes	Uncommon
Knut	60	Slips	Yes	Uncommon
Marline hitch	36	36% to 41%	–	–
Marlinspike hitch	32	–	No	No
Munter hitch	62	–	With backup	Small bits
Rolling hitch	38	–	No	Yes
Round turn with two half-hitches	28	6% to 30%	Yes	Yes
Running bowline	10	32% to 36%	With tie-off	Yes
Scaffold knot	17	40% to 43%	Yes	Binds
Schwäbisch hitch	58	Slips	Yes	Uncommon
Sheet bend	40	50%	No	No
Slippery sheet bend	40	50%	No	No
Timber hitch	26	7% to 31%	No	Yes
Twin bowline bend	39	Possibly around 60%	With backup	Yes
Valdôtain Tresse	54	Slips	Yes	Uncommon
Zeppelin bend	42	20% to 25%	With tie-off	Yes

* Note: strength reduction varies enormously – many of these results are from limited tests on a small range of ropes. Strength reduction on ultra-static technical fibres may exceed 90%. Use these figures as a rough guide only.

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Minimum Industry Standards

This document is one in a series of Minimum Industry Standards ("**MIS**") produced by Arboriculture Australia Ltd in partnership with the New Zealand Arboricultural Association and the wider arboriculture community to ensure that all people working, assessing and providing advice in relation to trees (excluding commercial forestry) have access to industry peer-reviewed documents explaining the core standards of skills and equipment with which competent practitioners should be familiar.

Where a MIS exists for a particular task, it is deemed by industry experts to:

- Provide an overview of the task, as it is practiced in industry.
- Define an industry consensus regarding the current appropriate applied-practice ways of conducting that task.
- Specify the minimum skill and knowledge requirements for performing particular tasks in the workplace.

At times, the complexity of a task may surpass the level of skill described in a MIS. It is the practitioner's responsibility to clearly understand and interpret the level of skill described in the MIS and whether that level is adequate for the task before them. In many cases a person will need to refer to several MIS documents to complete one task.

The prime purpose of the MIS is to provide minimum standards for the safety of tree workers, while still encouraging and fostering innovative practices.

Equipment, tests, inspection or practices other than those in this document may be perfectly satisfactory. Organisations are at liberty to provide different equipment, to specify different tests, or to inspect equipment in a manner or at intervals assessed as appropriate to particular circumstances, provided that these alternatives are based on sound design or reasoning and that the outcome of worker safety is not prejudiced.

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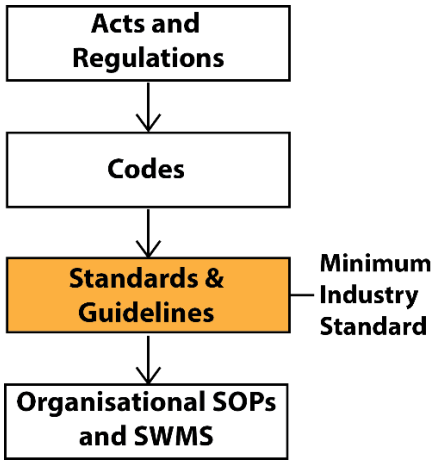
Both Arboriculture Australia Ltd and the New Zealand Arboricultural Association encourage any worker in any industry to conduct annual continued education and training to grow their competency in specific tasks and ensure they have appropriate training in the task being conducted prior to commencing any work.

The following diagram outlines the framework into which this MIS fits:



This MIS does not substitute for, or override, any legislation or regulation enacted by jurisdictional regulators or safety rules implemented by organisations. As depicted above, it is merely a guiding tool within the system.

Arboriculture Australia Ltd and the New Zealand Arboricultural Association will monitor the use and impact of these MIS and, consequently, may review and amend as the industry continues to evolve.

It is not the responsibility of Arboriculture Australia Ltd or of the New Zealand Arboricultural Association to notify users of these documents when reviews and reprints occur.

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Using the MISs in training and assessment

This document provides information that can be used to assist students/learners in gaining knowledge and understanding industry terminology and norms. Learning and practising skill components must be conducted under the supervision of a competent person or trainer. Do not attempt to practice any of the techniques described in this document without the supervision of a competent practitioner.

In Australia

A key outcome for the production of national MIS documents is their use to support training aligned to the units of competency from the Australian AHC Agriculture, Horticulture, Conservation and Land Management Training Package, in particular the arboricultural industry sector-specific units of competency.

The MIS for each work task defines an industry consensus of the benchmark of competence in a work task. Therefore, it is an assessment requirement for each unit of competency that the performance criteria, performance evidence and knowledge evidence demonstrated by the candidate is **at least** to the level described in the MIS for that work task.

Where units of competency are not specific in their description of the industry techniques or benchmark of ability expected of holders of that unit, RTOs should use the relevant MIS document as a supplementary guide for industry expectations when conducting training or designing assessment instruments.

This does not mean that techniques or equipment not described in the relevant MIS should not be taught or assessed. There are many ways to appropriately complete each task and some methods and equipment may be more advanced than those in this document.

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In New Zealand

A key outcome for the production of national MIS documents is their use to support training and education towards the New Zealand Certificates in Horticulture Services (Arboriculture) and Arboriculture. These Certificates (Levels 3 to 5) are designed to provide the arboriculture industry with individuals who have the technical skills and knowledge to safely undertake and manage arboriculture operations to maximise effectiveness.

The MIS for each work task defines an industry consensus of the benchmark of competence in a work task. The level at which the work task is assessed will reflect the New Zealand Qualification Authority (NZQA) Level, the Strategic Purpose of the qualification and the corresponding Educational and Employment Pathway. Depending on the relevant Graduate Profile, work tasks described in the MIS may address the content of more than one qualification and may progress more than one Education Pathway.

This does not mean that techniques or equipment not described in the relevant MIS should not be taught or assessed. There are many ways to appropriately complete each task and some methods and equipment may be more advanced than those in this document.

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Disclaimer for MISs and all associated documents

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Over time, changes in Australian and New Zealand Standards, industry standards and legislative requirements, as well as technological advances and other factors relevant to the information contained herein may affect the accuracy of the information contained in this document. Accordingly, caution should be exercised in relation to the use of the information in this document.

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The information in this document has been reviewed and validated by state and national industry representatives and deemed to be an accurate description of appropriate applied-practice skills and techniques. Arboriculture Australia Ltd and the New Zealand Arboricultural Association accept no responsibility or liability for the accuracy of any information contained herein, or the consequences of any person relying on such information. All arboriculture work is undertaken at your own risk.

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The development of the Minimum Industry Standards has been made possible by generous support from the following businesses who provided financial seed funding to the project to improve and increase education and safety in the arboriculture and vegetation management industries.

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This book is one in a series of Minimum Industry Standards developed by Arboriculture Australia Ltd. and the New Zealand Arboricultural Association in partnership with the national arboriculture and vegetation management communities in both countries. These industry peer-reviewed standards explain the skills and equipment with which competent practitioners should be familiar.

MIS301 ARBORIST KNOTS covers the basics of knot selection and knot tying, and presents the range of core knots every competent arborist should know.

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